2015-1280

In The
United States Court of Appeals
For The Federal Circuit

AGILENT TECHNOLOGIES, INC.,

Appellant,

v.

WATERS TECHNOLOGIES CORPORATION,

Appellee.

APPEAL FROM THE UNITED STATES PATENT AND TRADEMARK OFFICE, PATENT TRIAL AND APPEAL BOARD IN NO. 95/001,947.

CORRECTED BRIEF OF APPELLANT

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CERTIFICATE OF INTEREST

Pursuant to Federal Circuit Rule 47-4, counsel for the Appellant Agilent Technologies, Inc. certifies the following:

1) The full name of every party or amicus represented by me is: Agilent Technologies, Inc.

2) Agilent Technologies, Inc. is the real party in interest.

3) No publicly held companies hold more than 10% of the stock of Agilent Technologies, Inc.

4) The names of all law firms and the partners or associates that appeared for Agilent Technologies, Inc. and its predecessor in interest Aurora SFC Systems, Inc. in the proceedings below, or are expected to appear in this Court, are:

John M. Griem, Jr. and Theodore McDonough of Carter Ledyard & Milburn LLP,

Steven Kelber of Law Offices of Marc R. Labgold P.C.,

Rochelle Lieberman of Lieberman & Bradsdorfer, LLC.

Dated: June 5, 2015

Respectfully submitted:

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STATEMENT OF RELATED CASES

This appeal is a companion case to Appeal No. 15-1281. That appeal involves the same parties and relates to a different patent in the same technical field, also owned by Appellee Waters Technologies Corporation ("Waters"). Both the patent at issue in this appeal and the patent at issue in Appeal No. 15-1281 were asserted by Waters against Appellant Agilent Technologies, Inc.'s ("Agilent's") predecessor-in-interest, Aurora SFC Systems, Inc., in a patent litigation action filed on August 11, 2011 in the United States District Court of Delaware, *Waters Technologies Corp v. Aurora SFC Systems*, *Inc.*, Civil Action No. 1:11-cv-00708-JEI-KW. That direct court action is currently stayed pending the resolution of the reexamination that gave rise to this appeal.

No appeal from the same reexamination proceeding below has been before any appellate court.

JURISDICTIONAL STATEMENT

Agilent appeals a decision of the Patent Trial and Appeal Board issued on September 30, 2014, which reversed the Examiner's rejections of the claims while also applying new rejections to some of the claims. Neither party sought reconsideration or to reopen prosecution, making the Decision final under

37 C.F.R. § 41.81. Agilent timely filed a Notice of Appeal on December 19, 2014. This Court has jurisdiction, 35 U.S.C. § 141.[1]

STATEMENT OF THE ISSUES

1. Should Agilent be considered the Third Party Requestor following its contractual acquisition and assumption of all rights and obligations of the reexamination from Aurora SFC Systems, Inc. and Agilent's activities thereafter as the party requesting reexamination?

2. Did the Board err by declining to enter new grounds of rejection against dependent Claims 12 and 13, in view of (i) the Board's holding that corresponding independent Claims 1 and 9 are obvious, (ii) the unrebutted record evidence showing that the subject matter added by Claims 12 and 13 (use of CO_2 in a flow stream) is obvious over both Azimov and the Admitted Prior Art, and (iii) Waters' failure to argue the patentability of Claims 12 and 13 separately from Claims 1 and 9?

3. Did the Board err by narrowly construing the term "control" in Claims 1 and 9 to mean "to adjust to a requirement" or "regulate" during the period when the flow stream is maintained, such that a prior art differential pressure transducer

[1] The reexamination proceeding at issue was commenced in March 2012. The rules and statutes that govern the conduct of this review are thus those prior to the amendments attendant the adoption of the America Invents Act.

that is capable of controlling the pressure drop by monitoring and shutting off the flow stream is not considered to "control" the pressure drop as required?

STATEMENT OF THE CASE

Agilent, as successor-in-interest for Aurora SFC Systems, Inc., seeks review of the final decision of the United States Patent and Trademark Office, Patent Trial and Appeal Board, reported as *Aurora SFC Systems, Inc. v. Waters Technologies Corp.*, 2014 WL 4923558 (PTAB 2014). That decision was issued in Appeal 2014-003320 from an *inter partes* reexamination proceeding instituted by Agilent's predecessor-in-interest, Aurora SFC Systems, Inc., against Waters' U.S. Patent No. 6,648,609 B2, (the "'609 Patent"), Reexamination Control No. 95/001,947.

Before this court, Agilent appeals the Board's refusal to enter a new ground of rejection that Claims 12 and 13 are obvious after it found Claims 1, 2, and 9-11 obvious. Claims 12 and 13 depend from independent Claims 1 and 9, respectively, and further specify that the flow stream recited in the preamble of Claims 1 and 9 comprises CO_2, which the prior art teaches is well known. The Board erred by failing to enter a new ground of rejection for obviousness against Claims 12 and 13, in view of the undisputed record that use of CO_2 in a flow stream would be obvious and Waters' failure to argue the patentability of Claims

12 and 13 separately from the patentability of newly rejected Claims 1, 2, and 9-11.

Agilent also appeals the Board's reversal of the Examiner's rejections of Claims 1, 2, 3 and 5-13. These rejections were based on the Examiner's finding that the prior art patent to Azimov discloses a differential pressure transducer that "controls" the pressure drop across the restrictor/orifice, as required by independent Claims 1 and 9. The Board erred when it announced a new, narrower construction of the term "control" and found that under the new construction the differential pressure regulator disclosed in Azimov does not "control" the pressure drop as required, even though it can shut off the flow stream.

STATEMENT OF FACTS

A. The '609 Patent

The '609 Patent Abstract summarizes the alleged invention of the '609 patent as follows:

> The invention is a device and method in a high-pressure chromatography system, such as a supercritical fluid chromatography (SFC) system, that uses a pump as a pressure source for precision pumping of a compressible fluid. The preferred exemplary embodiment comprises a pressure regulation assembly installed downstream from a compressible fluid pump but prior to combining the compressible flow with a relatively incompressible modifier flow stream. The present invention allows the replacement of an high-grade SFC pump in the compressible fluid flow stream with an inexpensive and imprecise pump. The imprecise pump becomes capable of moving the compressible fluid flow stream in a precise flow rate and pattern. The assembly dampens the damaging effects of an imprecise pump,

> such as large pressure oscillations caused by flow ripples and noisy pressure signals that do not meet precise SFC pumping requirements.

A33 (Abstract of ’609 Patent). The background of the ’609 patent explains that supercritical fluid chromatography (SFC) is an alternative separation technology that uses highly compressed mobile phases, which typically employ carbon dioxide (CO_2) as a principal component. A40 (Col. 1:15-19).

The chromatography system described in the ’609 patent is not limited to a SFC environment: “However, as one skilled in the art will recognize, the invention may be used in any system where it is necessary to obtain steady flow of liquid at high pressure with high degrees of accuracy of pressure and flow using an imprecise pressure source.” A43 (Col. 8:57-64).

The use of a “forward pressure regulator”, then a restrictor (also referred to as an orifice) followed by a “back pressure regulator” in the pressure regulation assembly of the alleged invention is described in the Summary at Column 4, lines 24-36 (A41):

> The invention regulates the outlet pressure from a pump using a system of pressure regulators and a restriction in the flow stream. To regulate outlet pressure directly downstream of a pump, a forward-pressure-regulator (FPR) is installed in the flow line. Downstream of the forward-pressure regulator the flow is restricted with a precision orifice. The orifice can be any precision orifice, such as a jewel having a laser drilled hole or precision tubing. Downstream of the orifice is a back-pressure regulator (BPR). The series of an FPR-orifice-BPR is designed to control the pressure drop across the orifice, which dampens out oscillation from noisy pressure signals caused by large ripples in the flow leaving the pump.

The specification also describes an aspect of an additional embodiment that includes a "differential pressure transducer" to further regulate the change in pressure across the orifice:

> An additional embodiment uses a differential pressure transducer around the orifice with a servo control system to further regulate the change in pressure across the orifice. The combination allows the replacement of an expensive, SFC-grade pump having compressibility compensation with an inexpensive, imprecise pump such as an air-driven pump.

A41 (Col. 4:36-42). (This pressure transducer, originally claimed in dependent Claim 4, was later included in independent Claims 1 and 9 by amendment during reexamination. *See* A628-629.)

This alternative additional embodiment is first described in detail in Figure 3 and Column 7, lines 48-65. A36, A43. As explained there,

> A differential pressure transducer 58 can be installed on flow lines 54 and 56 around restrictive orifice 48 to control ΔP across the orifice 48. The differential transducer 58 is being used as a mass flow transducer and employs a servo control system for performing a servo algorithm to control the transducer 58 in accordance with the requirements of the present invention.

Figure 4 also describes the use of differential transducer 58 installed around restrictive orifice 48. A37, A43 (Col. 8:7-11). However, as described in the preferred embodiment, even where the transducer is included in the system, "flow control of a pressure source may be practiced without transducer 58." *Id.*

Before the operation of the differential pressure transducer is described, the ’609 Patent describes a situation where the pressure in the system becomes too high “through a system malfunction or inadvertent operator mistake.” A43 (Col. 7:22-25).

The patent specification does not further describe the operation of the differential pressure transducer, and its operation did not come up during prosecution leading to the ’609 patent.

As issued, the ’609 Patent presented eleven (11) claims, each directed to a system, with Claims 1 and 9 independent. A43-44. Substantively, Claims 1 and 9 differ only in that Clam 1 recites a “restrictor” for restricting flow downstream of the pump of the system, while Claim 9 recites an “orifice” downstream from the pump. A6, A44. Representative Claim 1 as issued recited:

> 1. A system for using a pump as a pressure source in a flow stream containing a highly compressed gas, compressible liquid, or supercritical fluid, comprising:
>
> a restrictor for restricting flow downstream of the pump;
>
> a forward pressure regulator located upstream of the restrictor for controlling the outlet pressure from the pump; and
>
> a back-pressure regulator located downstream of the restrictor, and a differential pressure transducer, where the back-pressure and forward-pressure regulators control the pressure drop across the restrictor.

Claim 4, which was later incorporated into Claims 1 and 9 during reexamination, recited:

4. The system of claim 1, further comprising:
a differential pressure transducer to control pressure drops across the restrictor.

B. <u>The Reexamination History</u>

A Request for *Inter Partes* reexamination of the ’609 Patent was filed by Aurora SFC Systems, Inc. (hereinafter “Aurora”) on March 27, 2012. A48. That Request identified a variety of prior art indicated to render the claims of the ’609 Patent anticipated or obvious, including newly identified patents to Azimov and Shoji. A108-118, A158-62. The Request also identified co-pending litigation brought by Waters, Appellee herein, asserting infringement by Aurora of the ’609 Patent, Civil Action No. 1:11-cv-00708-JEI-KW. A883-884. An Order granting reexamination, designating the proceeding as Control No. 95/001,947, and an initial Office Action rejecting all claims of the ’609 Patent was issued on May 7, 2012. A578-627.

In response, Patent Owner Waters filed a responsive amendment, amending independent Claims 1 and 9 to reflect the limitations of original Claim 4, and adding Claims 12 and 13, which depend from Claims 1 and 9, respectively. A628-629. Waters also submitted the Declaration of Lalit Chordia in support of the arguments presented in favor of patentability. A313-319.

In August 2012, some six months following the filing of the Request, Agilent Technologies, Inc. acquired substantially all of the assets of Aurora

(including all rights relating to the reexaminations). Dkt. 29 (Response of Agilent to Motion To Terminate Appeal, Exhibit A, Tang Declaration at ¶¶ 2, 4, 5). As part of that acquisition, Agilent also agreed to be bound by the outcome of the two reexamination proceedings, and the patent infringement litigation. *Id.* at ¶¶ 6, 7. As a consequence, Agilent, as successor-in-interest, advised the USPTO that it was the real party-in-interest, and requested the records be changed to reflect that status. Dkt. 29 (Response of Agilent to Motion To Terminate Appeal, Exhibit B, Request to Change The Real Party In Interest filed April 26, 2013). Waters acknowledged the acquisition of Aurora's assets by Agilent, and noted "Agilent Technologies Inc.'s agreement to be bound by the results of the pending reexaminations." Dkt. 29 (Response of Agilent to Motion To Terminate Appeal, Exhibit C, Notification of Prior Or Concurrent Proceedings in *Inter Partes* Reexamination).

An Action Closing Prosecution issued September 24, 2012. A630-662. The Examiner issued a Right of Appeal Notice rejecting all of the claims. A54-86. Waters filed a Notice of Appeal on all rejections. A663-664.

Agilent filed a Notice of Cross-Appeal. In the Notice of Cross-Appeal, Agilent sought review of the Decision of the Examiner not to reject Claims 1, 2, 9-11, 12 and 13 over the combination of U.S. Patent No. 4,799,411 to Azimov taken in view of U.S. Patent No. 5,952,556 to Shoji. A665-667.

Among issues contested in briefing on appeal to the Board was the proper construction of the term “control” as reflected in the phrase “control the pressure drop across the restrictor,” which appears at the end of Claim 1 and Claim 9. Claim 9 substitutes “orifice” for “restrictor” in this phrase, but this difference is immaterial for purposes of construing the term “control” A11-13. The claims on appeal are:

> 1. A system for using a pump as a pressure source in a flow stream containing a highly compressed gas, compressible liquid, or supercritical fluid, comprising:
>
> a restrictor for restricting flow downstream of the pump;
>
> a forward pressure regulator located upstream of the restrictor for controlling the outlet pressure from the pump; and
>
> a back-pressure regulator located downstream of the restrictor, and a differential pressure transducer, where the back-pressure regulator, forward-pressure regulator, and *the differential pressure transducer control the pressure drop across the restrictor*.
>
> 2. The system of claim 1, wherein the restrictor is a precision orifice.
>
> 3. The system of claim 1, further comprising: a temperature controller to control temperature across the restrictor such that the temperature remains as constant as practicable.
>
> 4. (Cancelled).
>
> 5. The system of claim 1, further comprising: a plurality of channels of the flow streams in parallel where pressure is controlled in each channel with separate groups of the forward-pressure regulator, the restrictor, and the back-pressure regulator in each of the channels.
>
> 6. The system of claim 1, further comprising: a plurality of channels of the flow stream in parallel where pressure is controlled in each

channel with separate groups of the pump, the forward-pressure regulator, the restrictor, and the back-pressure regulator for each of the channels.

7. The system of claim 6, further comprising: feeding each separate pump in each of the channels from a single source.

8. The system of claim 5, further comprising: a single multi-piston pump for combining second flow streams of a relatively incompressible fluid into each of the channels.

9. A system for using a pump as pressure source in a flow stream containing a highly compressed gas, compressible liquid, or supercritical fluid, comprising:

an orifice in the flow stream located downstream from the pump;
a first pressure regulator located upstream of the orifice; and a second pressure regulator located downstream of the orifice, and a differential pressure transducer, where the pressure regulators *and the differential pressure transducer control the pressure drop across the orifice*.

10. The system of claim 9, wherein: the first pressure regulator is a forward pressure regulator.

11. The system of claim 9, wherein: the second pressure regulator is back-pressure regulator.

12. The system of claim 1, wherein the flow stream comprises CO2.

13. The system of claim 9, wherein the flow stream comprises CO2.

A87-88 (emphasis added).

C. Azimov

U.S. Patent No. 4,799,511 to Azimov, A108-118, was identified during reexamination. It describes a four component system for distributing a fluid stream "at a constant rate of flow independent of fluctuations in discharge line pressures."

A108 (Abstract). With reference to Azimov's figures, the system 10 includes a pump, and fluid is sent from the pump into a conduit which includes a flow regulating device 38 which in turn includes a restrictor (which may be an orifice) downstream of the pump. A113 (Col. 6:31-43). There is a pressure regulator 24 upstream of the orifice and a back pressure regulator 44 downstream of the orifice. Azimov indicates that taken together, the pressure regulators and the flow controlling device 38 maintain pressure across the orifice constant. A114 (Col. 7:34-53). In particular, Azimov explains at column 7, lines 38-44:

> By utilizing a downstream pressure regulating device which is capable of maintaining a constant conduit line pressure P1 and an upstream pressure regulator which is capable of maintaining a second constant conduit line pressure P2, a constant pressure differential over the flow regulating device delta-P may be kept constant.

Id.

Azimov also includes a differential pressure transducer (referred to as "flow switch 32", A17-18, Board Finding of Fact 14) which "monitors the rate of the moving material in conduit 30, detecting inadequate or excessive flow rates, and responding to these endogenous changes by signaling the servo-mechanism through the leads contained in line 32a. In addition, flow switch 32 responsively reacts to the effects of changes which take place outside of the system 10." A114-115 (Col. 8:67–Col. 9:5).

Azimov teaches that when flow and/or pressure exceed operating tolerances, a servo-mechanism is employed to stop the system at column 9, lines 26-32:

> Changing the rate of flow within the system, in turn, triggers the flow switch to intercede, thereby stopping the continued functioning of the system through the intervention of the servo-mechanism. The kind of servo-mechanism to be employed…is immaterial to the present invention, making specific components thereof neither part of nor claimed by the present invention.

A115. Switch 32 is a differential pressure transducer because it detects changes or differentials in pressure and transmits this information to a servomechanism electronically. The Board so found. A15-17 (Findings of Fact 5, 14).

The Board also found that the system of Azimov is, in terms of its component elements, identical to system recited in the independent claims of the '609 Patent. A17-18 (Findings of Fact 9-14). However, the Board found that Azimov does not anticipate the systems of Claims 1 and 9 on the basis that Azimov's differential pressure transducer "is capable only of monitoring and shutting off a pressure drop across the flow regulation device 38. The flow switch 32 does not adjust or regulate the pressure drop either [sic] during the period when the flow is maintained." A18 (Findings of Fact 15-17).

D. <u>Shoji</u>

U.S. Patent No. 5,952,556 to Shoji, A158-162, was also newly identified during reexamination. In its most relevant disclosure, it describes a chromatographic system using one pressure regulator and a differential pressure

transducer or sensor which transmits a signal representative of the differential pressure it senses to a control element which directs control valve to alter the flow rate through the device. A161 (Col. 1:41-50).

E. <u>The Board's Decision</u>

The Board decision reversed the Examiner's rejections of all the pending claims after holding that the Examiner had incorrectly construed the claim term "control," such that the independent claims were not anticipated by the prior art patent to Azimov. A22. The Board found that while Azimov taught a system of components identical to that of the subject matter of independent Claims 1 and 9, A17-18 (Findings of Fact 9-14), Azimov did not anticipate the last element of those claims. The Board reasoned that for the differential pressure transducer to "control" the pressure drop across the regulator as required, it must "adjust to a requirement" or "regulate" the pressure drop while the flow is being maintained. A11-13 (Board claim construction of "control"), A18 (Finding 16 (applying claim construction to require adjustment or regulation of the pressure drop during the period when the flow is maintained)).

Although the Board recognized that the claims do not require that the control effected by the differential pressure transducer be "dynamic", A12, the Board found that "the term 'control' itself implies adjustment or regulation." *Id*. Because the Board found that the differential transducer of Azimov could only turn off the

flow, not adjust it while it was being maintained, it found that Azimov did not anticipate Claims 1 and 9. A18 (Finding of Fact 16).

The Board introduced a new ground of rejection, however, finding Claims 1, 2 and 9-11 to be obvious over Azimov and Shoji. The Board found that it would have been obvious to use the pressure regulator and differential pressure transducer control system of Shoji in the twin pressure regulators on either side of an orifice system of Azimov to effectively control pressure drops caused by using a pump as a pressure source. A23-30. As urged by Agilent in its Cross-Appeal, the Board found that Shoji, "teaches using the combination of a differential pressure transducer and a control valve to act as a back-pressure regulator." A28. The Board concluded that "[i]t would have been obvious from the combined teachings of Azimov and Shoji to substitute the combination of the differential pressure transducer and the control valve taught by Shoji for the back-pressure regulator described by Azimov so that the combination might act as a back-pressure regulator in Azimov's system." A28.

The Board declined to enter a new ground of rejection based on obviousness against dependent Claims 12 and 13. A30-31. These Claims were cross-appealed as invalid over Azimov and Shoji in Agilent's Notice of Cross-Appeal. A665-667. Claims 12 and 13 both recite the use of CO_2 in the flow stream referred to in the preamble of independent Claims 1 and 9. A88. These claims were added by

Waters during reexamination, which argued that they were valid for the same reasons that newly rejected Claims 1, 2 and 9-11 were allegedly valid. A680-699. The Examiner had found Claims 12 and 13 invalid as obvious over Azimov and in light of the prior art systems described in the background of the ’609 patent, which both described and suggested the use of CO_2 in a flow stream. A62-63.

The Board declined to enter new grounds of rejection for Claims 12 and 13 on the basis that the Requestor Agilent had not explained “how either Azimov or Shoji, or a combination of the two, teaches or suggests these limitations.” A31. The Board did not consider or acknowledge the undisputed evidence in the record of the obviousness of these limitations, or the fact that Waters argued their validity based on limitations found only in newly rejected Claims 1 and 9. *See* A680-699.

SUMMARY OF THE ARGUMENT

A. Agilent Is Now The Third Party Requestor And A Party To The Reexamination Proceedings With A Right To Appeal

As noted by the Court in its Order denying Waters’ Motion To Dismiss The Appeal, “[t]he Patent Act at the time relevant to these proceedings defined a ‘third party requester’ as the ‘person ***requesting*** . . . inter partes reexamination,’ 35 U.S.C. § 100(e) (emphasis added), not the person who ***requested*** reexamination.” Dkt. 35 (emphasis in original). And 35 U.S.C. § 315(b)(1) expressly provides that the third-party requester “may appeal . . . with respect to any final decision

favorable to the patentability of any original or proposed amendment or new claim of the patent."

Agilent, as legal successor-in-interest and privy to the reexamination rights and liabilities of Aurora, has stepped into the shoes of Aurora and actively pursued invalidation of the claims of the '609 Patent. The Board has raised no objection, and Waters has acknowledged Agilent's position and assumption of the liabilities of an adverse reexamination decision.

The Court should confirm Agilent's status as Third Party Requestor entitled to appeal the Board's decision and participate as a party in the reexamination going forward.

B. The Board Erred By Failing To Enter A New Ground Of Rejection As To Claims 12 and 13

The Board should have entered a new ground of rejection against Claims 12 and 13 after it held Claims 1, 2 and 9-11 obvious over Azimov in view of Shoji.

There is no dispute that the validity of Claims 12 and 13 depends entirely on independent Claims 1 and 9, from which they depend. The bases for invalidity of Claims 12 and 13 as well as Claims 1, 2 and 9-11 are set forth in Agilent's Notice of Cross-Appeal, and the invalidity of claims 12 and 13 was inextricably linked to that of the other claims in all of the parties' papers on appeal. Waters rested all of its arguments for validity of Claims 1, 2 and 9-13 based solely on the limitations of claims 1 and 9. Waters never argued the validity of Claims 12 and 13 based on the

one additional limitation appearing in each of Claims 12 and 13, use of CO_2 in a flow stream. The Board ultimately rejected all of Waters' arguments in favor of the validity of Claims 12 and 13 when it entered the new grounds of rejection of claims 1, 2 and 9-11 for obviousness.

In light of the undisputed record evidence of the invalidity of Claims 12 and 13, Board erred when it declined to include Claims 12 and 13 in the new grounds for rejection based on obviousness. The Court should therefore hold Claims 12 and 13 invalid as obvious, where – as here – there is no dispute over any material fact relating to obviousness of those claims. *Agilent Technologies*, *Inc.*, *v. Affymetrix*, *Inc.* 567 F.3d 1366, 1383 (Fed. Cir. 2009). Alternatively, the failure to reject Claims 12 and 13 is at very least not consistent with the rejection of Claims 1 and 9 where the claim limitations at issue in the invalidity analysis were identical. In *Q.I. Press Controls*, *B.V. v. Lee*, 752 F.3d 1371, 1383 (Fed. Cir. 2014), *reh'g denied* (Oct. 15, 2014), the Federal Circuit held that the Board has an obligation to enter a new ground of rejection when failure to do so leads to inconsistent results. If the Court is not inclined to find Claims 12 and 13 obvious, it should vacate the Board's refusal to enter a new ground of rejection as to Claims 12 and 13 and remand for further proceedings consistent with its decision.

C. The Board Committed Legal Error In Construing "Control" To Be Limited To Adjustment Of A Continuing Flow Stream

The Board erred as a matter of law in failing to give the term "control" its broadest reasonable interpretation, in light of the intrinsic evidence and the prior art. The Board's definition incorrectly excluded the most basic kind of "control" – the ability to turn something off. The claim language expressly requires only that the differential pressure transducer "control the pressure drop across" the restrictor or orifice. It says nothing about "adjust[ing]" the flow stream, as required by the construction adopted by the Board. The specification of the '609 patent suggests that one of the requirements of the described system is to be able to turn off the flow stream in the event the pressure exceeds system tolerances. The prior art patent to Azimov expressly teaches that one way to exercise control over a pressure drop across an orifice is to cut off the flow stream. The Board therefore erred when it relied on an incomplete dictionary definition provided by Waters to construe the term "control" contrary to the intrinsic evidence and the broadest reasonable construction applied by the Examiner.

The Decision of the Board below reversing the Examiner's rejections of Claims 1, 2, 3, 5-13 should be reversed, and the Examiner's rejections reinstated, and a judgment of invalidity entered in favor of Appellant Agilent.

ARGUMENT

A. Standard Of Review

Agilent's status as the Third Party Requestor is subject to plenary review by the Court, based on its application of the relevant statutory provisions. *Syntex (U.S.A.) Inc. v. U.S. Patent & Trademark Office*, 882 F.2d 1570, 1573 (Fed. Cir. 1989). This issue was raised for the first time on appeal by Appellee, Dkt. 25, and the Court directed the parties to address it in their briefs, Dkt. 31.

The standard of review for the second issue, whether the Board erred in not entering a new ground of rejection against Claims 12 and 13, is based on 5 U.S.C. § 706. That statute empowers this Court with a scope of review that allows it, among other things, to set aside agency action, findings and conclusions (such as the one here) that are arbitrary, capricious, an abuse of discretion, not in accordance with law, and/or unsupported by substantial evidence. 5 U.S.C. § 706.

The Court's review of the third issue – the Board's erroneously narrow construction of the term "control" in Claims 1 and 9 – is *de novo.* The Board construed this term based on its ordinary meaning and the specification, and did not rely on any expert evidence to resolve disputed factual issues. A6-7, A11-12, 18. Consequently, this Court's review of the Board's claim construction is without deference. *In re Cuozzo Speed Technologies*, *LLC*, 778 F.3d 1271, 1282-83 (Fed.

Cir. 2015); *In re Papst Licensing Digital Camera Patent Litigation*, 778 F.3d 1255, 1260-61 (Fed. Cir. 2015).

On the third issue, the Board's factual findings underlying a decision of obviousness (or non-obviousness) are reviewed for substantial evidence while related legal conclusions are reviewed *de novo*. *In re Baxter Int'l, Inc.*, 678 F.3d 1357, 1361 (Fed. Cir. 2012). The ultimate determination of obviousness under § 103 is a question of law based on underlying factual findings. *Id.* (citing *Graham v. John Deere Co.*, 383 U.S. 1, 17-18, 86 S. Ct. 684, 15 L. Ed. 2d 545 (1966)). What a reference teaches and the differences between the claimed invention and the prior art are questions of fact which the Court reviews for substantial evidence. *Id.* (citations omitted).

B. Agilent Should Be Confirmed As The Third Party Requestor

As noted by the Court in its Order denying Water's Motion To Dismiss The Appeal, the Patent Act at the time relevant to these proceedings defined a "third party requester" as the "person ***requesting*** . . . inter partes reexamination," 35 U.S.C. § 100(e) (emphasis added), not the person who ***requested*** reexamination. Dkt. 35. And, 35 U.S.C. § 315(b)(1) expressly provides that the third-party requester "may appeal . . . with respect to any final decision favorable to the patentability of any original or proposed amendment or new claim of the patent."

Agilent, as successor-in-interest and privy of Aurora, the party that filed the reexamination, enjoys the protection extended by the statutes. Agilent expressly acquired all rights, responsibilities and obligations relating to this reexamination, as part of an acquisition of substantially all of Aurora's assets in August 2012. Dkt. 29 (Response of Agilent to Motion To Terminate Appeal, Exhibit A, Tang Declaration at ¶¶ 2, 4, 5). After that date, Agilent became Aurora's privy and successor-in-interest to its rights as Third Party Requestor. Agilent assumed control of prosecuting the reexamination, and among other activities filed an Appellant's Brief, a Respondent's Brief, and appeared at Oral Hearing, having notified the Board that it was the real party-in-interest, in accordance with the policy and requirements of the USPTO. A709-736 (Agilent's Appellant's Brief), 756-793 (Agilent's Respondent's Brief).

Neither the USPTO Examiner or the Board raised any objection to Agilent's assumption of responsibility and liability for pursuing the reexamination. And in companion *Inter Partes* Reexamination Control No. 95/001,910, Waters filed a Brief on Appeal on July 25, 2013, in which it acknowledged that Agilent had stepped into the shoes of Aurora as successor-in-interest, observing "Aurora requested that the real party- in-interest be changed to Agilent Technologies, Inc. …Agilent did agree to be bound by this reexamination. For the sake of continuity, Waters will continue to refer to the third-party requester as 'Aurora' but

incudes in that designation Agilent." Dkt. 29 (Response of Agilent to Motion To Terminate Appeal, Exhibit C, Notification of Prior Or Concurrent Proceedings in Inter Partes Reexamination, at page 2, n.1).

The Board's acceptance of Agilent as successor to Aurora is not surprising considering that the Board has expressly accepted the principle that a successor-in-interest to a Third-Party Requester may file a brief and otherwise contest the Reexamination initiated by its predecessor-in-interest. In *University of Pittsburgh v. Cellerix*, 2013 WL 6328581 (PTAB 2013), the party Cellerix filed the initial request for Inter Partes Reexamination. *Id.* at *1. Subsequent to the filing of the Request, the Patent Owner appealed and the third-party requester cross-appealed. The Briefs of the Requester on Cross-Appeal were in fact filed by a second company, TiGenix SAU, not Cellerix. The Board accepted the briefs of TiGenix and specifically observed that:

> TiGenix SAU is listed as the successor-in-interest of Cellerix SL, the party who filed the Request for Inter Partes Reexamination (Respondent Br. 2 dated October 19, 2012). Only the party originally requesting inter partes reexamination is entitled to file a brief, or a party who is a privy. 37 C.F.R. § 41.60, 37 C.F.R. § 1.915(b)(8).

Id. at n.1 (parenthetical in original)

In exactly the same fashion, the Board in this matter below accepted a brief from Agilent as the real party-in-interest, noting that Agilent is identified as the successor-in-interest to Aurora, the party filing the original request for

reexamination. A2 (Fn.1). The Court should confirm Agilent's status as Third Party Requestor entitled to conduct the reexamination going forward.[2]

C. <u>The Board Erred By Failing To Enter A New Ground Of Rejection Against Claims 12 And 13 As Obvious Over Azimov In View Of Shoji And Admitted Prior Art</u>

The Board should have entered a new ground of rejection against Claims 12 and 13 because their patentability depends entirely on the patentability of Claims 1 and 9, which the Board held invalid in new grounds of rejection. Claims 12 and 13 each limit Claims 1 and 9, respectively, to a system for using a pump as a pressure source in a flow stream "wherein the flow stream comprises CO_2."

Claims 12 and 13 were identified as being unpatentable over Azimov and Shoji under § 103(a) in Agilent's Notice of Cross-Appeal. A4, A665-667. In the Notice of Cross-Appeal, Agilent expressly incorporated the Examiner's reasons for rejecting Claims 12 and 13 in the Right of Appeal Notice:

> The Third Party Requestor had proposed rejecting Claim 4, which depended from Claim 1, over Azimov in view of Shoji, a rejection adopted by the Examiner. ***Upon the Amendment of July 9, 2012 incorporating Claim 4 into Claims 1 and 9, that rejection should have been applied to the newly amended and presented claims as well. <u>See</u> the Examiner's treatment of Claims 12 and 13 with respect to Proposed Rejection 10, Right of Appeal Notice dated January 23, 2013, pages 9-10***, and the consideration of Proposed

[2] The Court is respectfully referred to Agilent's Opposition to Waters' Motion To Dismiss The Appeal for further authority supporting Agilent's right to continue this reexamination in the shoes of Aurora. Dkt. 29.

Rejections 5 and 6, confined originally to Claim 4, RAN, pages 15-16. A665-667 (emphasis added).

In the portion of the Right of Appeal Notice cited by Agilent, at pages 9-10, the Examiner expressly applies the rejection of Claims 1, 2, 4 and 9, as obvious in light of Azimov and in view of the Admitted Prior Art in the background of the '609 patent, to new Claims 12 and 13 (A63):

> The claims claim the flow stream comprises carbon dioxide. The specification of the '609 patent gives no specifics of changes of structure that might be required to pump carbon dioxide. As such, any system, such as Azimov capable of pumping a highly compressed gas, compressible liquid or compressible liquid [sic] is capable of pumping carbon dioxide, particularly a system (such as Azimov) that controls pressure drop across a restrictor which will reduce the chance of forming solid carbon dioxide. It is further noted that pumping carbon dioxide through pressure regulator and restrictors is shown to be known in line 18 of column 1 and line 52 of column 2 [of the '609 Patent]. As such, using the system of Azimov to pump carbon dioxide is seen as obvious to an ordinary practitioner in the art to provide a highly compressed, liquid or supercritical carbon dioxide stream. A63.

In light of the obviousness of the additional element added by Claims 12 and 13, it is no surprise that Waters never treated Claims 12 and 13 as separately patentable from Claims 1 and 9. On appeal to the Board, Waters never disagreed with the Examiner's grounds for rejection of Claims 12 and 13, or argued that the use of CO_2 in a flow stream confers patentability separate from the limitations of the base claims. Before the Board, Waters rested its arguments for the patentability of claims 1, 2, 9-11 **and 12-13** on the limitations of independent Claim 1. A7, A675-

699, A700-701,[3] A741-754. Agilent expressly noted in its Respondent's Briefs to the Board that Waters is not separately arguing the patentability of Claims 12 and 13. A781-82, A816. Like the Board, Waters focused its arguments on the issue of whether Azimov, either alone or in combination with Shoji, describes a system include a differential pressure transducer, where a back-pressure regulator, a forward pressure regulator and the differential pressure transducer control the pressure drop across a restrictor. A7, A680-699, A753-754. Neither Waters nor the Board identified the obviousness of the use of CO_2 in a flow stream as an issue on appeal.

As explained by the Examiner in the Right of Appeal Notice, there is no reasonable dispute that a person of ordinary skill would find using CO_2 in the flow stream system of Azimov to be obvious. The Admitted Prior Art in the background of the '609 patent cited by the Examiner states unequivocally that use of carbon dioxide in the flow streams of chromatography systems, such as SFC systems, is old in the art. A40 (Col. 1:15-20 ("An alternative separation technology called supercritical fluid chromatography (SFC) has advanced over the past decade. SFC uses highly compressed mobile phases, which typically employ

[3] Waters does argue that the Examiner did not make a *prima facie* case of obviousness for Claims 12 and 13 because the Examiner did not cite a prior art reference for the teaching that CO_2 was known. A701. Waters never argues that the subject matter of Claims 12 and 13 is not obvious in light of the Admitted Prior Art in the background of the '609 Patent.

carbon dioxide (CO2) as a principle [sic] component.")); Col. 2:39-47 ("SFC systems in the prior art have used modified HPLC high-pressure pumps operated as a flow source. . . . The delivery of carbon dioxide varied with pressure and flow rate. . . . Pumping compressible fluids, such as CO2, at high pressures in SFC systems while accurately controlling the flow, is much more difficult than that for a liquid chromatography system.").

In view of the undisputed record that Claims 12 and 13 are obvious if Claims 1 and 9 are obvious, and the fact that the patentability of these two claims rested on the patentability of the Claims the Board newly rejected, the Board's stated reason for declining to enter new grounds of rejection against Claims 12 and 13 is not supported by substantial evidence and arbitrarily draws a distinction between Claims 1, 2 and 9-11 and Claims 12 and 13. The Board said the "Requestor does not explain how either Azimov or Shoji, or a combination of the two, teaches or suggests these limitations." A31. But Board was well aware of the Admitted Prior Art in the '609 patent teaching the use of CO2 in flow streams, as the Board refers to the Admitted Prior Art in the course of its decision. A22-23.[4] Agilent should not be required to make an unnecessary explanation about undisputed facts, when all of the evidence of record, unrebutted by Waters, shows

[4] The "Admitted Prior Art" is defined by the Third Party Requestor at pages 73-75 of the original Request for Reexamination. A21, citing A62-63.

that Claims 12 and 13 are obvious. *See Randall Mfg. v. Rea*, 733 F.3d 1355, 1363 (Fed. Cir. 2013) (reversing the Board after finding that the prior art of record showed that it was known to stow a bulkhead near the ceiling).

Moreover, Agilent ***did*** explain how these claims are obvious, under any fair reading of the record, when it tied invalidity of these two claims to the Examiner's reasons for rejecting them in the RAN as part of its Cross-Appeal of Claims 1, 2, and 9-13. Agilent expressly noted that Waters never separately argued the validity of Claims 12 and 13 in its Respondent's Briefs. A781-82, A816. And Agilent argued the invalidity of Claims 12 and 13 in other places in its briefs before the Board, without citing the Admitted Prior Art, because there was no dispute in the record that Claims 12 and 13 were patentable only if Claims 1 and 9 were patentable.

Once the Board concluded that Azimov in light of Shoji made obvious claims 1, 2, and 9-11, there was no procedural or substantive basis for the Board to decline to enter a new ground of rejection against Claims 12 and 13 as obvious. 35 U.S.C. § 706 empowers this Court with a scope of review that allows it, among other things, to compel agency action unlawfully withheld and to set aside agency action, findings and conclusions (such as the one here) that are arbitrary, capricious, an abuse of discretion, not in accordance with law, and/or unsupported by substantial evidence. As there is no dispute of material fact that the use of CO_2

in a flow stream of the claimed systems is obvious when taken together with the elements of Claims 1, 2 and 9-11 which the Board held obvious, Agilent is entitled as a matter of law to a judgment of invalidity of Claims 12 and 13. *See Agilent Technologies*, *Inc.*, *v. Affymetrix*, *Inc.*, 567 F.3d 1366, 1383 (Fed. Cir. 2009) (reversing and entering judgment in favor of appellant where there was no dispute of material fact and appellant was entitled to judgment as a matter of law).

Alternatively, the Court should reverse the Board's decision declining to enter new grounds of rejection as to Claims 12 and 13 and remand for further proceedings consistent with its decision. The Board expressly acknowledged that Agilent had asked it to exercise its power to enter new grounds of rejection against Claims 12 and 13. However, the Board declined to do so for a reason that was both unsupported by substantial evidence in the record, and arbitrary, capricious and an abuse of discretion. Under 35 U.S.C. § 706 and this Court's precedential decision in *Q.I. Press Controls*, *B.V. v. Lee*, 752 F.3d 1371, 1383 (Fed. Cir. 2014), *reh'g denied* (Oct. 15, 2014), the Court can and should vacate the Board's erroneous basis for entering a new ground of rejection and direct the Board to consider entering a new ground of rejection against Claims 12 and 13 in light of the record evidence and arguments supporting obviousness of those claims and Waters' failure to argue their patentability separately from newly rejected Claims 1, 2 and 9-11.

D. <u>The Board Committed Legal Error In Construing "Control" To Require Adjustment Of A Flow Stream</u>

Central to the Board's reversal of the Examiner's rejections was its decision to overrule the Examiner and construe the term "control" narrowly. A11-13. The Board construed the term "control" to be limited to meaning only "adjust to a requirement" or "regulate." A11-12 (bridging sentence). This erroneous construction resulted in reversal of all of the Examiner's rejections.

The Board should have given this term its "broadest reasonable interpretation", in light of the specification from which it is drawn. *In re Cuozzo Speed Technologies*, *LLC*, 2015 WL 448667, at *6 (Fed. Cir. 2015) ("This court has approved of the broadest reasonable interpretation standard in a variety of proceedings, including initial examinations, interferences, and post-grant proceedings such as reissues and reexaminations."); *see also In re Am. Academy of Science Tech Center*, 367 F.3d 1359, 1364 (Fed. Cir. 2004) ("Giving claims their broadest reasonable construction 'serves the public interest by reducing the possibility that claims, finally allowed, will be given broader scope than is justified.'") (quoting *In re Yamamoto*, 740 F.2d 1569, 1571-72 (Fed. Cir. 1984). Although the Board says that it is applying the "broadest reasonable interpretation" standard, A7-8, it did not actually do so.

In Claims 1 and 9, the term "control" is used in the phrase "control the pressure drop across the" restrictor or orifice. A6, A87-88. Nothing in the claims

limits that "control" to the narrowly defined meaning of "control" imposed by the Board. The claims do not have any language that requires that the flow stream be continuous, or that the differential pressure transducer "control" the pressure drop only during operation of the pump or while the flow stream is continuously operating. While the Board acknowledged that nothing in the '609 Patent specifies that the control involved is "dynamic," it nevertheless asserted that the term "'control' itself implies adjustments or regulation." A12.

The Board appears to have been led astray by Waters' arguments relying on an incomplete definition of the ordinary verb "control" taken from the website "thefreedictionary.com." This incomplete definition was supplied by Waters in a footnote in its Rebuttal Brief. A11-12 (expressly citing footnote 1 containing the dictionary definition). But Waters supplied only one of four definitions for the verb "control" found at thefreedictionary.com.[5] The others demonstrate that the ordinary and broadest reasonable meaning of "control" includes a wide variety of types of control, including the ability to prevent something from continuing.

Moreover, the Board was wrong to find its construction of the term "control" to be "consistent" with usage of that term in the '609 Patent specification. A12. The '609 Patent describes the differential transducer as being used to accomplish the "requirements of the invention," one of which is monitoring the system for

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[5] (http://www.thefreedictionary.com/control) (last visited May 5, 2015).

excess pressure caused by “system malfunction or inadvertent operator mistake.” A43 (Col. 7:22-25). Although the ’609 Patent does not elaborate in detail on how the described system will react to excess pressure, the prior art patent to Azimov unmistakably teaches that the proper response is to shut off the pump or the flow stream in order to protect the system. A112-113 (Col. 4, ln. 64 to Col. 5, ln. 5), A115 (Col. 9, lns. 26-35), A15-16 (Board Findings of Fact 5 and 6). Accordingly, a person of ordinary skill, familiar with the prior art and the plain meaning of the term “control”, would consider shutting off the system entirely as one way to address a “system malfunction or inadvertent operator mistake” - one of the requirements of the invention.

1. The Board Failed to Give the Word “Control” Its Broadest Reasonable Interpretation Consistent With Its Ordinary Meaning

The Board relied on the Waters’ proposed “ordinary meaning” of the word “control” to construe that term as used in the claim phrase “control the pressure drop across the restrictor [or orifice]”. A11-12. But Waters did not give the Board the complete definition of the ordinary meaning of the word “control.” The meaning of “control” is broader than “to adjust to a requirement” or to “regulate”, as suggested by Waters.

This is one of those cases where “the ordinary meaning of claim language as understood by a person of skill in the art may be readily apparent even to lay judges, and claim construction in such cases involves little more than the

application of the widely accepted meaning of commonly understood words." *Phillips v. AWH Corp.*, 415 F.3d 1303, 1314 (Fed. Cir. 2005) (*en banc*).

According to thefreedictionary.com, the source relied on by Waters for the "ordinary" meaning of "control", there are four definitions of the verb "control", not just one, as suggested by Waters. These four definitions demonstrate the wide range of actions that can be taken to "control" something – in this case, the pressure drop across the restrictor/orifice. In the definitions below, examples of use are shown in italics:

1. To exercise authoritative or dominating influence over; direct: *The majority party controls the legislative agenda.*

2. To adjust to a requirement; regulate: *rules that control trading on the stock market; valves that control the flow of water.*

3. To hold in restraint; check: *struggled to control my temper*.

4. To reduce or prevent the spread of: *used a pesticide to control insects; controlled the fire by dousing it with water*.

Waters picked the second one, which it said was appropriate "[i]n the context of a machine or system." A836-840.

But it is clear from a review of the four possible definitions that ***all of them could have application in the context of a machine or system.*** The ordinary

meaning of "control" certainly includes stopping something, in addition to adjusting it to a requirement or regulating it during operation.

Similarly, the meaning of "regulate" includes the action of stopping some activity, in addition to moderating activity while it is still going on. Therefore, even under the construction adopted by the Board, which equated "control" with "regulate", the broadest reasonable construction of the term "control" includes the action of stopping something, in addition to adjusting it during operation. Indeed, temporarily stopping something from operating (such as the pump or flow stream of the claimed system) may be necessary to regulating its operation.

The Board erred by imposing an unduly narrow construction on the claim term "control" that was contrary to its ordinary meaning and broadest reasonable construction. Had Waters wanted to claim the system as being limited to "active" control or adjustment or regulation during operation (by excluding control that requires stopping the system), it could have amended the claims to expressly limit them in that way. Waters, in a passage cited and relied on by the Board, characterized the term "regulate" as one that "connotes active control or adjustment of the pressure as the highly variable media oscillates in mass flow and pressure." A12 (citing App. Br. PO 17, A688). If Waters believed that this was the required level of "control" over the pressure drop, it was free to amend the claims to limit them to this type of control during reexamination.

Because Waters did not so amend the claims, the broadest reasonable interpretation of "control" should be applied. That definition does ***not*** exclude control by stopping the operation of the claimed system. *See*, *e.g.*, *In re Yamamoto*, 740 F.2d 1569, 1571 (Fed. Cir. 1984) ("The PTO broadly interprets claims during examination of a patent application since the applicant may 'amend his claims to obtain protection commensurate with his actual contribution to the art.'") (quoting *In re Prater*, 415 F.2d 1393, 1404-05, 162 USPQ 541, 550, 56 CCPA 1381, 1395 (1969)); *see also In re Zletz*, 893 F.2d 319, 321-22 (Fed. Cir. 1989) (the broadest reasonable construction of claims during examination serves to target ambiguities in claims at the time when the claims are readily amended).

2. The Board Failed to Give the Word "Control" Its Broadest Reasonable Interpretation Consistent With The Specification

The '609 specification also describes the operation of the claimed systems in a way that does not place any restrictions on the meaning of the word "control" as used in the claims, when that term is referring to the operation of the back pressure regulator, forward pressure regulator, and differential pressure transducer to "control the pressure drop" across the restrictor (or orifice).

In the claims, Waters chose to use the word "controls" instead of "regulates" when referring to the operation of the differential pressure transducer. This choice suggests that the claim term "controls" should be given a broader meaning that the meaning of "regulate" that the Board applied. The specification, in the Summary

of the invention, describes the operation of the differential transducer using the term "further regulate" at Column 4, lines 24-42:

> The series of an FPR [forward pressure regulator]-orifice-BPR [back pressure regulator] is designed to control the pressure drop across the orifice, which dampens out oscillation from noisy pressure signals caused by large ripples in the flow leaving the pump. An additional embodiment uses a differential pressure transducer around the orifice with a servo control system ***to further regulate*** the change in pressure across the orifice. The combination allows the replacement of an expensive, SFC-grade pump having compressibility compensation with an inexpensive, imprecise pump such as an air-driven pump.

By using the term "controls" in the claims, when the specification uses the term "regulates", Waters made a deliberate choice to use the broader term "controls".

Nor is there any discussion in the specification of particular structure for the differential pressure transducer that would justify the Board's narrow construction. The exact structure by which the differential pressure transducer actually "controls" or "further regulates" the pressure drop across the orifice is not described in the specification, however, presumably because those of ordinary skill would appreciate that there are many ways in which the transducer could activate some mechanism that would serve to control the pressure drop. As further discussed below in Section B.3, one of those methods is the shut-off method described by Azimov.

The specification also suggests that reacting to excessive pressure in the system is one of the requirements of the invention met by the differential pressure

transducer. The specification notes that the differential transducer uses a "servo control system" to control the pressure drop across the orifice, and that it does so "in accordance with the requirements of the present invention":

> A differential pressure transducer 58 can be installed on flow lines 54 and 56 around restrictive orifice 48 to ***control*** ΔP across the orifice 48. The differential transducer 58 is being used as a mass flow transducer and employs a servo control system for performing a servo algorithm to control the transducer 58 ***in accordance with the requirements of the present invention***.

A43 (Col. 7:59-65) (emphasis added). The specification also describes the risk of column pressure becoming too high through "system malfunction or inadvertent operator mistake." A43 (Col. 7:23-25). Reacting to such a situation is presumably one of the "requirements" of the described system addressed by the differential transducer. In light of the specification, it was error for the Board to limit the scope of "control the pressure drop" to "adjust to a requirement; regulate" only while the flow stream is maintained.

The sole portion of the '609 disclosure relied on by the Board for its narrow construction is the portion discussed above at Column 4, lines 24-42. A12. Arguably, this portion of the specification uses the word "regulates" interchangeably with the word "controls" in describing the operation of the BPR, FPR and differential transducer to control the pressure drop over the restrictor or orifice.

But even if the specification should be read to make “controls” and “regulates” equivalent, that alleged equivalence is ***not*** enough to justify the Board’s decision to impose a claim construction narrower than the broadest reasonable interpretation of “control.” The Board improperly limited the ordinary meaning of “control” to be limited to “adjust or regulate the pressure drop either [sic] during the period when the flow is maintained”. A18 (Finding of Fact 16). It was on the basis of this improperly narrow construction that the Board held that the cut-off flow switch of Azimov (which it had previously found to be a differential pressure transducer, Finding of Fact 14, A17-18) did not anticipate Claims 1 and 9.

Because the specification does not ***require*** that the construction of “control the pressure drop across the restrictor” (or orifice) be limited to control only while the flow stream is passing through the restrictor, *see In re Morris*, 127 F.3d 1048, 1054 (Fed. Cir. 1997), the Board’s construction of “control” should be reversed, and the Examiner’s rejections of all the claims reinstated. Even if “regulate” is considered one ordinary meaning of “control”, the meaning of “regulate” still encompasses the concept of shutting off the flow in order to regulate the flow stream. Under the proper broadest reasonable interpretation, the flow switch of Azimov together with the other structure disclosed therein anticipates Claims 1 and 9 and supports reinstating the Examiner’s rejections of all of the claims.

3. The Board's Narrow Construction Impermissibly Excludes A Method Of "Control" Over A Flow Stream Shown In the Prior Art

As previously discussed, the '609 patent describes the possibility of excessive pressure building up in the claimed system "through a system malfunction or inadvertent operator mistake." A43 (Col. 7: 22-25). The differential pressure transducer required by Claims 1 and 9 is described in the specification as further regulating the change in pressure across the orifice in accordance with the "requirements" of the "present invention." A43 (Col. 7, 61-65). But the exact mechanism of how the system reacts to excess pressure is not precisely described, presumably because it can be any mechanism that was well known to persons of ordinary skill in the art.

For example, the prior art Azimov patent describes a very similar system and control mechanism, and demonstrates how a person of ordinary skill would understand the operation of the embodiment of the '609 Patent described in Column 7. The Azimov reference is analogous art and contains all structural elements of Claims 1 and 9. A16-18 (Findings of Fact 7-14). In Azimov, if there is inadequate or excessive flow (or pressure) sensed by the differential pressure transducer (which the Board found to be flow switch 32 in Azimov, Finding of Fact 14, A17-18), it responds by "signaling the servo-mechanism." A114-115. If the pressure drop (referred to in Azimov as delta P) changes too greatly, that

"triggers the flow switch to intercede, thereby stopping the continued functioning of the system through the intervention of the servo-mechanism." A115 (Col. 9:21-29). The servo algorithms referred to in the '609 Patent, A43 (Col. 7:61-65), appear to be the same sort of algorithms employed in Azimov, and for the same purpose. *See* A110 (Fig. 3) and A117 (Col. 13:47–Col. 14:17).

In sum, a person of ordinary skill would understand that the systems of both the '609 Patent claims and Azimov maintain pressure within system limits by use of pressure regulators. When the differential pressure transducer senses a problematic change in the pressure across the orifice, it activates a servomechanism. The servomechanism of the differential pressure transducer of both the '609 Patent (reference character 58) and Azimov (switch 32) "control" the pressure drop by shutting the system down.

Certainly, there is absolutely nothing in the '609 Patent that ***prohibits*** the differential pressure transducer of Claims 1 and 9 from controlling the pressure drop by shutting the system down. Nor can anything in the specification of the '609 patent be read as an express disclaimer of prior art methods of "control" by a differential pressure transducer over the pressure drop across a restrictor or an orifice in a flow control system. An express disclaimer is required before a claim construction that excludes a disclosed embodiment of a patent can be correct. *Pacing Technologies*, *LLC v. Garmin Intern.*, *Inc.*, 778 F.3d 1021, 1025 (Fed. Cir.

2015). This Court recently reiterated the black-letter patent claim construction principle that "[w]e do not generally construe the claims of a patent to exclude a preferred embodiment." *In re Papst Licensing Digital Camera Patent Litigation*, 778 F.3d 1255, 1270 (Fed. Cir. 2015) (citing *Adams Respiratory Therapeutics, Inc. v. Perrigo Co.*, 616 F.3d 1283, 1290 (Fed. Cir. 2010)).

Thus, nothing in the '609 Patent excludes from the scope of the claims "control across the pressure drop" that is effected by shutting down a system based on pressure exceeded operational limits. Because the broadest reasonable interpretation embraces the broadest meaning of the claim language selected by the applicants, and the specification does not require a narrower meaning, *see, e.g.*, *Tempo Lighting, Inc. v. Tivoli, LLC*, 742 F.3d. 973, 9787 (Fed. Cir. 2014); *In re Morris*, 127 F.3d 1048, 1054 (Fed. Cir. 1997), the Board's construction cannot be the broadest reasonable interpretation.

CONCLUSION AND STATEMENT OF RELIEF SOUGHT

Agilent is now the Third Party Requestor as successor in interest and contractual privy of Aurora, and the Court should so confirm.

The Court should direct the Board to enter judgment on Claims 12 and 13 in favor of Agilent, in light of the lack of any dispute of fact as to the obviousness of those claims, or vacate the Board's refusal and direct it to consider entering new grounds of rejection against Claims 12 and 13.

The Board's reversal of the rejection of all claims over Azimov in view of secondary references other than Shoji should be reversed, in light of the Board's erroneously narrow construction of the term "control", the claims finally rejected, and judgment of invalidity entered in Agilent's favor.

Respectfully submitted,

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ADDENDUM

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UNITED STATES PATENT AND TRADEMARK OFFICE

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

PTOL-90A (Rev. 04/07)

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AURORA SFC SYSTEMS, INC.,[1]
Respondent, Requester, Cross-Appellant

v.

WATERS TECHNOLOGIES CORPORATION,
Appellant, Patent Owner

Appeal 2014-003320
Reexamination Control 95/001,947
Patent No. 6,648,609 B2[2]
Technology Center 3900

Before STEVEN D.A. McCARTHY, JEFFREY B. ROBERTSON, and DANIEL S. SONG, *Administrative Patent Judges*.

McCARTHY, *Administrative Patent Judge*.

DECISION ON APPEAL

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[1] The Requester identifies the real party in interest as "Agilent Technologies, Inc.[,] the successor-in-interest to the Third Party Reexamination Requester, Aurora SFC Systems, Inc." (Appellants' Brief dated May 8, 2013 ("App. Br. Req'r") at 2; *see also* Respondent's Brief in *Inter Partes* Reexamination dated June 7, 2013 ("Resp. Br. PO") at 2 n.1).

[2] Issued November 18, 2003 to Terry A. Berger; Kimber D. Fogelman; Kenneth Klein; L. Thomas Staats, III; Mark Nickerson; and Paul F. Bente, III (the "′609 patent"). The ′609 patent issued from Appl. 10/117,984, filed April 5, 2002.

STATEMENT OF THE CASE

The Appellant/Patent Owner appeals from the Examiner's decision adopting rejections of claims 1-3 and 5-13. Independent claim 1 has been amended to incorporate the subject matter of dependent claim 4 of the ′609 patent. The only other independent claim, claim 9, also has been amended to add a limitation formerly appearing in claim 4. Claim 4 of the ′609 patent is cancelled. New claims 12 and 13 were added during the reexamination proceeding. ("Appellant's Brief in *Inter Partes* Reexamination dated" May 8, 2013 ("Patent Owner's Appeal Brief" or "App. Br. PO") at 2; *see also* "Appellants' Brief" dated May 8, 2013 ("Requester's Appeal Brief" or "App. Br. Req'r") at 6). The Patent Owner and the Requester participated in oral argument on April 23, 2014, a transcript of which was entered into the record on May 28, 2014. We have jurisdiction over the Patent Owner's appeal under 35 U.S.C. § 134(b) (2011) and 35 U.S.C. § 315(a) (2011).[3]

In a Right of Appeal Notice mailed January 23, 2013 ("RAN")[4], the Examiner adopted proposed rejections of:

> claims 1, 2 and 9-11 under 35 U.S.C. § 102(b) (2011) as being anticipated by Azimov (US 4,799,511, issued Jan. 24, 1989) (Ground 9);

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[3] The Requester and the Patent Owner also are parties to a lawsuit in *Waters Technologies Corp. v. Aurora SFC Systems, Inc.*, Civil Action No. 11-708-RGA (D. Del.). As presently advised, the lawsuit is stayed pending the resolution of this proceeding and of Reexamination Control No. 95/001,910. (App. Br. PO 2).

[4] The Examiner's Answer mailed December 9, 2013, incorporates the RAN by reference.

> claims 1, 2, 9, 12 and 13 under 35 U.S.C. § 103(a) (2011) as being unpatentable over Azimov and Admitted Prior Art ("APA") detailed on pages 73-75 of the "Request for *Inter Partes* Reexamination of U.S. Patent No. 6,648,609," dated March 27, 2012 ("Request") (Ground 10);
>
> claim 3 under §103(a) as being unpatentable over Azimov and Wang (US 5,642,278, issued Jun. 24, 1997) (Ground 11);
>
> claim 5 under § 103(a) as being unpatentable over Azimov and Müller-Kuhrt (US 6,532,978 B1, issued Mar. 18, 2003) (Ground 14);
>
> claims 6-8 under § 103(a) as being unpatentable over Azimov, in view of the APA and Müller-Kuhrt (Ground 15); and
>
> claims 5-8 over Gertenbach (Gertenbach *et al.*, *Modeling of Bench-Scale Coal Liquefaction Systems*, 21 INDUSTRIAL & ENG'RING CHEM. PROCESS DESIGN & DEVELOPM'T 490-500 (Am. Chem. Soc'y 1982)), Azimov and Müller-Kuhrt (Ground 22).

(RAN 4-5 and 9-12).

We do not sustain the grounds of rejection adopted by the Examiner.

The Respondent/Requester cross-appeals from the Examiner's non-adoption of a rejection of claims 1, 2 and 9-13 under § 103(a) as being unpatentable over Azimov and Shoji principally based on the fact that claim 4 (now canceled) was previously rejected as being unpatentable over Azimov and Shoji, and the limitation appearing in claim 4 has now been

incorporated into independent claims 1 and 9. (Notice of Cross-Appeal dated March 8, 2013; App. Br. Req'r 9).

"On judicial review, the correctness of the decision appealed from can be defended by the *appellee* on any ground that is supported by the record, whether or not the appellant raised the argument." *Rexnord Indus. LLC v. Kappos*, 705 F.3d 1347, 1355-56 (Fed. Cir. 2013). This is true even if the Examiner did not expressly adopt the ground. *See Randall Mfg. Co. v. Rea*, 733 F.3d 1355, 1363 n.3 (Fed. Cir. 2013). The Requester's right to raise the issue of rejecting claims 1, 2 and 9-13 under § 103(a) as being unpatentable over Azimov and Shoji is supported by the particular record here because: (1) the Requester proposed rejecting claim 4 on this ground at pages 81-84 the Request; (2) the Examiner initially determined that the Requester had shown a reasonable likelihood of prevailing as to the rejection of claim 4 on this ground (Order Granting/Denying Request for *Inter Partes* Reexamination mailed May 7, 2012 at 15-16); and (3) the Patent Owner amended independent claims 1 and 9 to incorporate the limitation separately recited in claim 4 of the ′609 patent (App. Br. PO 2; App. Br. Req'r 6).

Pursuant to our authority under 37 C.F.R. § 41.77(b) (2011), we enter a new ground of rejection against claims 1, 2 and 9-11 under § 103(a) as being unpatentable over Azimov and Shoji. We decline to enter a new ground of rejection against claims 12 and 13 under §103(a) as beng unpatentable over Azimov and Shoji.

THE CLAIMED SUBJECT MATTER

Claims 1 and 9 are independent. Claim 1, reproduced with italics added for emphasis, is illustrative:

> 1. A system for using a pump as a pressure source in a flow stream containing a highly compressed gas, compressible liquid, or supercritical fluid, comprising:
>
> a restrictor for restricting flow downstream of the pump;
>
> a forward pressure regulator located upstream of the restrictor for controlling the outlet pressure from the pump; and
>
> a back-pressure regulator located downstream of the restrictor, *and a differential pressure transducer, where the back-pressure regulator, forward pressure regulator, and the differential pressure transducer control the pressure drop across the restrictor*.

(App. Br. PO at 32 (Claims App'x)).

Claim 9 similarly recites a "system for using a pump as a pressure source in a flow stream containing a highly compressed gas, compressible liquid, or supercritical fluid." The system of claim 9, like that of claim 1, includes a differential pressure transducer, "where the pressure regulators and the differential pressure transducer control the pressure drop across the orifice." (*See* App. Br. Req'r 8 ("However, as the first pressure regulator is recited as located upstream of the orifice/restrictor, and the second pressure regulator is recited as located downstream of the orifice/restrictor, there is no difference between Claims 1 and 9 in terms of their elements, other than semantics.")).

THE RECORD

The Patent Owner relies on the Patent Owner's Appeal Brief; a Respondent's Brief in *Inter Partes* Reexamination dated June 7, 2013 ("Patent Owner's Resp. Brief" or "Resp. Br. PO"); and a Rebuttal Brief dated January 9, 2014 ("Patent Owner's Rebuttal Brief" or "Reb. Br. PO"). The Patent Owner also relies on a Declaration Pursuant to 37 C.F.R. § 1.132 executed by Dr. Lalit Chordia on July 9, 2012 ("Chordia Decl."). The Requester relies on the Requester's Appeal Brief; a "Respondent's Brief" dated August 15, 2013 ("Requester's Respondent Brief" or "Resp. Br. Req'r"); and a Third Party Requester's Rebuttal Brief dated January 9, 2014 ("Requester's Rebuttal Brief" or "Reb. Br. Req'r"). The RAN incorporates by reference portions of the Request.

ISSUES

The Patent Owner does not argue the patentability of claims 2 and 9-13 separately from the patentability of claim 1 in this appeal. Two issues are dispositive: *First*, does Azimov describe a system including a differential pressure transducer, where a back-pressure regulator, a forward pressure regulator and the differential pressure transducer control a pressure drop across a restrictor? *Second*, if not, does Shoji remedy the deficiency?

CLAIM INTERPRETATION

During reexamination, claim terms are given their broadest reasonable interpretation consistent with the specification. "Therefore, we look to the specification to see if it provides a definition for claim terms, but otherwise

apply a broad interpretation." *In re ICON Health & Fitness, Inc.*, 496 F.3d 1374, 1379 (Fed. Cir. 2007).

"Pump"

The Patent Owner argues that the preamble recitations of claims 1 and 9 limit the subject matter of those claims. "[A] claim preamble has the import that the claim as a whole suggests for it." *Bell Communications Research, Inc. v. Vitalink Communications Corp.*, 55 F.3d 615, 620 (Fed. Cir. 1995).

> If, however, the body of the claim fully and intrinsically sets forth the complete invention, including all of its limitations, and the preamble offers no distinct definition of any of the claimed invention's limitations, but rather merely states, for example, the purpose or intended use of the invention, then the preamble is of no significance to claim construction because it cannot be said to constitute or explain a claim limitation.

Pitney Bowes, Inc. v. Hewlett-Packard Co., 182 F.3d 1298, 1305 (Fed. Cir. 1999). The Patent Owner has not cited to any authority suggesting that, if one term in the preamble limits the claimed subject matter, the entire preamble must be limiting.

The preambles of claims 1 and 9 identically recite "system[s] *for using* a pump as a pressure source in a flow stream containing a highly compressed gas, compressible liquid, or supercritical fluid." (Italics added for emphasis). The language "system for using . . ." implies that the preambles recite intended uses or purposes of the claimed systems. As such,

the preambles of claims 1 and 9 as a whole do not limit the subject matter of the claims.

The body of claim 1 recites "a restrictor for restricting flow *downstream of the pump*; a forward pressure regulator located upstream of the restrictor . . . [and] a back-pressure regulator located downstream of the restrictor." In other words, claim 1 uses the pump to define the location of the restrictor and uses the location of the restrictor to define the location of the forward pressure regulator and the back-pressure regulator. Because the recitation of the pump in the preamble helps to define the limitations set forth in the body of the claim, the recitation of a pump in the preamble is limiting. (*See* Resp. Br. PO 11; Reb. Br. PO 11-12).

Nevertheless, as pointed out by counsel for the Requester during oral argument, the inclusion of the pump in the claimed combination does not imply that the claimed combination must include a pump specifically used as a pressure source in a flow stream containing a highly compressed gas, compressible liquid, or supercritical fluid. (*See* Record of Oral Hearing 17, ll. 17-24 and 18, l. 19 – 19, l. 4). In particular, the Patent Owner has not pointed to any recitation in claim 1 or claim 9, or to any disclaimer in the Specification, which persuasively suggests that the nature of the fluid material to be pumped through the system should be read as a limitation on the system itself.

"Flow Stream Containing a Highly Compressed Gas, Compressible Liquid, or Supercritical Fluid"

The Patent Owner argues that the "flow stream containing a highly compressed gas, compressible liquid, or supercritical fluid" recited in the

preambles of claims 1 and 9 must be understood as the flow stream in a supercritical fluid chromatography ("SFC") apparatus or a similar high pressure chromatography apparatus. (*See* App. Br. PO 10). Neither claim 1 nor claim 9 positively recites SFC apparatus. This omission implies that the broadest reasonable interpretation of claim 1 and claim 9 does not limit those claims to systems conducting flows for use in SFC processes or limit the claimed subject matter to only those systems with pumps designed for SFC processes. (*See* RAN 24).

This understanding is consistent with the Specification, which describes the claimed subject matter as "well suited" to an SFC environment but does not limit the subject matter to that environment: "However, as one skilled in the art will recognize, the invention may be used in any system where it is necessary to obtain steady flow of liquid at high pressure with high degrees of accuracy of pressure and flow using an imprecise pressure source." (′609 patent, col. 8, ll. 57-64). Although the Specification states that "[t]he invention *relates* to a device and method for using a pump as a pressure source . . . in a high-pressure chromatography system, such as supercritical fluid chromatography," (′609 patent, col. 1, ll. 9-12 (italics added for emphasis)), nothing in the Specification states that the claimed subject matter is limited to an SFC or high pressure chromatography environment. (*See* Resp. Br. Req'r 9-10; Record of Oral Hearing 20, ll. 15-17 and 21, ll. 5-22).

"Differential Pressure Transducer"

The Patent Owner does not appear to identify any formal definition or clear disclaimer in the Specification which might suggest that claims 1 and 9

use the term "differential pressure transducer" more narrowly than its ordinary usage. We agree with the Patent Owner that a "transducer is simply a device that transmits a signal in one form of energy, based on measurement of another form of energy." (Resp. Br. Req'r 15; *accord* MCGRAW-HILL DICTIONARY OF ENG'RING (McGraw-Hill, 2nd edition, 2003)("transducer")("any device or element which converts an input signal into an output signal of a different form")). A "differential pressure transducer" is a device that transmits a signal in one form of energy (such as an electrical signal) based on measurement of differential pressure.

"Where the Back-Pressure Regulator, Forward Pressure Regulator, and the Differential Pressure Transducer Control the Pressure Drop Across the Restrictor"

Neither the Examiner nor the Requester appears to identify any formal definition or clear disclaimer in the Specification which might suggest that claims 1 and 9 use the term "control" more broadly than its ordinary usage. Neither does the Patent Owner appear to identify any evidence or persuasive technical argument suggesting that one of ordinary skill in the art might understand the term differently than a lay person. The Requester argues that, "[i]n failing to offer a definition of a term—control—which [the Patent Owner] now relies on to distinguish the claimed invention from the prior art, the patent should be construed using the plain and ordinary meaning of the term 'control.'" (Resp. Br. Req'r 13). The Requester does not appear to state what it believes to be the ordinary meaning of the term, however.

Therefore, we agree with the Patent Owner that the ordinary meaning of the term "control" is "to adjust to a requirement" or to "regulate." (Reb.

Br. PO 2 and n.1). This usage is consistent with that in the Specification. (*See* App. Br. PO 17 ("The [S]pecification makes clear that the claimed components, including the differential pressure transducer, 'regulate' the pressure drop across the restrictor/orifice. *See* '609 patent at 4:24-42. To 'regulate' connotes active control or adjustment of the pressure as the highly variable media (*e.g.*, CO_2, operating at or near supercritical level) oscillates in mass flow and pressure.")). Although, as the Requester points out at pages 17-19 of its Respondent Brief, neither claim 1 nor claim 9 recites that the control is "dynamic," the term "control" itself implies adjustment or regulation.

The Requester concedes that "[i]t is immediately apparent that amended claim 1 and original claim 4 are of identical scope." (App. Br. Req'r 11). Claim 4, as it existed in the ′609 patent prior to this reexamination proceeding, recited the "system of claim 1, further comprising: a differential pressure transducer to control pressure drops across the restrictor." In other words, claim 4 independently recited that the differential pressure transducer controlled the pressure drop. Since the amended claim 1 on appeal in this proceeding is identical in scope to claim 4, claim 1 must also be read as limited to a system in which the differential pressure transducer controls the pressure drop. (*Cf.* Record of Oral Hearing dated May 28, 2014 at 22, l. 8 – 23, l. 2 (arguing that, since claim 1 as originally issued in the ′609 patent recites control of the pressure drop by the pressure regulators without reference to the differential pressure transducer, amended claims 1 and 9 are not limited to systems in which the pressure regulators and the differential pressure transducers cooperate to control the pressure drop)). Despite the Requester's argument to the contrary at pages

17-19 of the Requester's Respondent Brief, the differential pressure transducer recited in claims 1 and 9 either must itself control the pressure drop across the restrictor or orifice, or it must contribute to the control of that pressure drop.

FINDINGS OF FACT

The record supports the following findings of fact ("FF") by a preponderance of the evidence.

Azimov

1. Azimov describes "provid[ing] a linear flow system of static parameters to accurately and continuously maintain a constant rate of flow of a fluid or a gas to a discharge point despite significant fluctuations in supply line and discharge line pressures." (Azimov, col. 3, ll. 21–26). In particular, Azimov teaches supplying heating oil or natural gas to a furnace or boiler at a precisely controlled constant discharge rate. (Azimov, col. 5, ll. 40-43).

2. Azimov describes a fuel delivery system *10* including a supply line conduit *12* and a discharge conduit *52*. (Azimov, col. 5, ll. 62–66; col. 11, l. 67 – col. 12, l. 3; and Fig. 2[5]). Azimov generally describes "flowing material enter[ing] the system via a conduit system and pump apparatus provid[ing an] initial unregulated rate [of] flow and pressure." (Azimov, col. 3, ll. 41-43; *see also id.*, col. 8, ll. 2–5).

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[5] Although columns 5-7 of Azimov describe the embodiment of Figure 1, the embodiment of Figure 2 includes similar components acting in a similar fashion.

3. Azimov's system *10* includes a pressure regulator *24* for maintaining a constant pressure *P1* in a conduit *26* downstream of the pressure regulator *24*. (Azimov, col. 6, ll. 20–23 and Fig. 2). In addition, the system *10* includes a back pressure regulator *44* for maintaining a constant pressure *P2* in a conduit line *40* upstream of the back pressure regulator *44*. (Azimov, col. 6, ll. 44–48 and Fig. 2). Conduit *26* communicates with the conduit *40* through a flow regulating device *38* in the form of an orifice. (Azimov, col. 6, ll. 31–35 and Fig. 2). In other words, the pressure regulator *24*, the back pressure regulator *44* and the flow regulating device *38* are connected in series, with the pressure regulator *24* upstream of the flow regulating device *38* and the back pressure regulator *44* downstream of the flow regulation device *38*.

4. Azimov teaches that:

> The ability of the system to provide precise amounts of material at constant discharge rate and pressure range is based on the combination of components employed therein. By utilizing a downstream [that is, forward] pressure regulating device [*24*] which is capable of maintaining a constant conduit line pressure **P1** and an upstream [that is, back] pressure regulator [*44*] which is capable of maintaining a second constant conduit line pressure **P2**, a constant pressure differential over the flow regulating device [*38*] delta-**P** may be kept constant. By keeping the pressure through the flow regulating device constant as well as by keeping the effective orifice area through the flow regulating device constant, the system is able to dispense a constant amount of material. Hence, by taking advantage of the unique combination of components, a material such as heating oil may be

> pumped into the system at an unregulated pressure and rate of flow wherein the pressure and flow rate are modified to constant levels which comport with the needs of the burner or other discharge apparatus.

(Azimov, col. 7, ll. 34–53). After providing a more abbreviated description of the system operation earlier in the written disclosure, Azimov states that "it is evident that there is no need for a by-pass line to sample internal conditions and to regulate the system; a linear self-maintaining system results." (Azimov, col. 3, ll. 56-59).

5. Azimov's system *10* includes a flow switch or transducer *32*. The flow switch *32* monitors the flow between the pressure regulator *24* and the flow regulating device *38* to detect inadequate or excessive flow. (Azimov, col. 8, l. 67 – col. 9, l. 14 and Fig. 2). Azimov teaches that:

> A change in the delta-**P** value changes the pressure with which the material moves through the flow metering device, and this increase or decrease of pressure forces either more or less material through the unchanging orifice within the flow regulating device [*38*]. Changing the rate of flow within the system, in turn, triggers the flow switch [*32*] to intercede, thereby stopping the continued functioning of the system through the intervention of the servo-mechanism [no reference numeral].

(Azimov, col. 9, ll. 21–29).

6. Azimov teaches the use of either mechanically-controlled or electrically-controlled components for regulating pressure. (*Compare* Azimov, col. 1, ll. 55-68 *with id.*, col. 2, l. 65 – col. 3, l. 4). Azimov does not appear to criticize or disparage the use of electrically-controlled components for regulating pressure. (*See*, *e.g.*, *id.*)

Azimov is Not Non-Analogous Art

7. The Patent Owner argues that Azimov is non-analogous art. (*See* App. Br. PO 24-26). Azimov is *reasonably* pertinent to the problem with which the named inventors of the ′609 patent were involved. The ′609 patent teaches that the claimed subject matter is "suitable" for use in SFC but states that the claimed subject matter may also address a broader problem. The ′609 patent identifies that problem generally as "obtain[ing] steady flow of liquid at high pressures with high degrees of accuracy of pressure and flow using an imprecise pressure source." (′609 patent, col. 8, ll. 59-64). Azimov teaches a system which receives fluid at an initially unregulated pressure and flow rate. Azimov's system produces a flow of material having accurately maintained flow rate and discharge pressure. (*See* FF 4, quoting Azimov, col. 7, ll. 34–53). Although Azimov does not specifically address a flow system for use in SFC, it is reasonably pertinent to the problem stated in the Specification of the ′609 patent.

8. The Patent Owner's expert states that he "would not have looked to Azimov for a solution for use in chromatography because Azimov's shut-down feature would not meet precise SFC pumping requirements. . . . Furthermore, Azimov does not pertain to chromatography. As a result, Azimov's device does not have an immediate applicability for use in SFC systems." (Chordia Decl., para. 34). The expert's statement is not persuasive. As the Requester points out, the Patent Owner's expert is not an expert in patent law. As such, the expert has identified the problem with which the named inventors were involved too narrowly as SFC or high pressure chromatography rather than as defined by the preamble of claims 1

and 9, and by the Specification of the '609 patent as a whole. (*See* Resp. Br. Req'r 20-21).

Azimov Does Not Anticipate Independent Claim 1 or Independent Claim 9

9. Azimov describes a system *10* for using a pump. In particular, Azimov describes the use of a "pump apparatus provid[ing an] initial unregulated rate [of] flow and pressure" to the system. (FF 2, quoting Azimov, col. 3, ll. 41-43; *see also id.*, col. 8, ll. 2-5; Resp. Br. Req'r 14).

10. Specific to claim 1, Azimov's system *10* includes a restrictor for restricting flow downstream of the pump. The restrictor takes the form of the flow regulation device *38*, which may be an orifice. (FF 3).

11. Azimov's system *10* also includes the forward pressure regulator *24* and the back pressure regulator *44*. The forward pressure regulator *24* is upstream of the restrictor or flow regulating device *38* and the back pressure regulator *44* is downstream of the restrictor. (FF 3). The forward pressure regulator *24* controls the outlet pressure from the pump by maintaining a constant pressure *P1* in supply line conduit *12* downstream of the pressure regulator *24*. (*Id.*)

12. Specific to claim 9, Azimov's system *10* includes an orifice. The orifice is an element of the flow regulation device *38*. (FF 3 and 10).

13. Azimov's system *10* also includes a first pressure regulator *24* located upstream of the orifice of the flow regulating device *38* and a second pressure regulator *44* located downstream of the orifice. (*See* FF 3 and 11).

14. Both the Examiner and the Requester identify Azimov's flow switch *32* as corresponding to the differential pressure transducer recited in claim 1 and claim 9. (*See* RAN 9, incorporating by reference Request 81;

Resp. Br. Req'r 15-17). Azimov's flow switch *32* is a differential pressure transducer because it senses a flow signal near the flow regulating device *38* and transmits that flow signal to a servo-mechanism. (FF 5, citing Azimov, col. 8, l. 67 – col. 9, l. 14; *see also* Resp. Br. Req'r 15-16). Since the flow through the flow regulation device *38* correlates with the pressure differential across the flow regulation device, the flow switch *32* is a differential pressure transducer. (FF 5, citing Azimov, col. 9, ll. 21–29; *see also* Resp. Br. Req'r 16).

15. Although most of the limitations of claim 1 read on the system described by Azimov, Azimov does not anticipate claim 1. In particular, neither the Examiner nor the Requester has proven that Azimov describes a system in which "the back-pressure regulator, forward pressure regulator, *and* the differential pressure transducer control the pressure drop across the restrictor." (Italics added for emphasis).

16. Azimov's flow switch *32* does not control the pressure drop across the restrictor as recited in claim 1. Azimov's flow switch *32* is capable only of monitoring and shutting off a pressure drop across the flow regulation device *38*. The flow switch *32* does not adjust or regulate the pressure drop either during the period when the flow is maintained. (*See* App. Br. PO 18; Reb. Br. PO 2). There is no pressure drop to adjust or regulate during the period when the flow is shut off.

17. Neither the Examiner nor the Requester identifies any other structure described by Azimov which might correspond to the differential pressure transducer recited in claim 1.

Wang, Müller-Kuhrt and Gertenbach

18. In rejecting claim 3, the Examiner cites Wang as teaching the use of a pressure controller in a flow stream containing a highly compressed gas, compressible liquid or supercritical fluid. (RAN 28-29; *see also* RAN 10, incorporating by reference Request 79 (quoting Wang, col. 5, ll. 34-39)).

19. In rejecting claim 5, the Examiner finds that Müller-Kuhrt "is seen to teach a plurality of channels in a high pressure flow system with controls for the respective flows through each of the channels." (RAN 29; *see also* RAN 11, incorporating by reference Request 87 (quoting Müller-Kuhrt, col. 7, l. 68 – col. 8, l. 10)). That said, the Examiner also finds that Müller-Kuhrt "does not teach differential pressure transducers in conjunction with pressure regulators which are positioned upstream and downstream from a restrictor." (RAN 29-30).

20. The Examiner correctly finds that "Gertenbach does not teach the combination of a differential pressure transducer with a forward and back pressure regulator to control the pressure drop across a restrictor." (Ans. 20 (referring to Ground 20)).

Shoji

21. Figure 1 of Shoji depicts a prior art gas chromatograph including a pressurized tank or bomb *1* for supplying a carrier gas; a sample introducing portion *6*; an analysis column *7* for separating a sample introduced into the carrier gas in the sample introducing portion *6*; and a detecting portion *8* for analyzing the separated components of the sample. (Shoji, col. 1, ll. 21-27; *see also id.*, col. 1, ll. 50-56). Shoji teaches that it was known to precisely control the carrier gas introduced from the bomb *1*

into the sample introducing portion *6* to ensure the accuracy of the chromatographic analysis. (Shoji, col. 1, ll. 14-20).

22. The prior art gas chromatograph depicted in Figure 1 also includes a resistance tube *3* downstream of the bomb *1*; a pressure regulator *2* located upstream of the resistance tube *3*; and a control valve *5* located downstream of the resistance tube *3*. (Shoji, col. 1, ll. 21-27).

23. Shoji teaches measuring and controlling the carrier gas introduced into the sample introducing portion *6* by means of a differential pressure transducer or sensor *4* which measures the difference in pressure between the upstream and downstream sides of the resistance tube *3*. (*See* Shoji, col. 1, ll. 14-20 and 28-29). The differential pressure sensor *4* transmits a signal representative of the differential pressure to a control portion *9*. The control portion *9* signals the control valve *5* based on the signal from the differential pressure sensor *4* so as to maintain the pressure differential across the resistance tube *3* at a set pressure difference. (Shoji, col. 1, ll. 41-50).

24. In this manner, the differential pressure sensor *4* together with the pressure regulator *2* and the control valve *5* controls the flow rate of gas introduced into the sample introducing portion *6*. (*Id.*) The description in Shoji implies that the differential pressure sensor or transducer *4* and the control valve *5* together act as a back pressure regulator to maintain the pressure drop between the forward pressure regulator *2* and the back pressure regulator.

25. Shoji teaches that the flow rate of the carrier gas is proportional to the pressure of the gas flow upstream of the resistance tube *3* and to the pressure drop across the resistance tube *3*. (Shoji, col. 1, ll. 29-40). Shoji

additionally teaches that the pressure regulator *2* maintains the upstream pressure uniform. (Shoji, col. 1, l. 57 – col. 2, l. 2).

26. Shoji teaches that the pressure supplied from the bomb *1* varies depending on the quantity of gas remaining in the bomb, the temperature and the like. (Shoij, col. 1, ll. 57-59). Shoji does not mention any substantial pressure fluctuations in the supply pressure upstream of the pressure regulator *2* or the discharge pressure downstream of the control valve *5*.

27. Shoji teaches that the pressure regulator *2* is expensive. (Shoji, col. 1, l. 65 – col. 2, l. 2). In order to reduce or eliminate the cost of the expensive pressure regulator, Shoji teaches replacing the pressure regulator with a pressure sensor upstream of the resistance tube. (*See* Shoji, col. 2, ll. 52-63; *compare id.*, Fig. 1 *with id.*, Fig. 2). The control portion *9* takes into account both the signal from the differential pressure sensor *4* and the upstream pressure sensor *21* in controlling the control valve *5* to maintain a constant flow rate of the carrier gas. (Shoji, col. 2, l. 64 – col. 3, l. 10).

Shoji is Not Non-Analogous Art

28. The Patent Owner argues that Shoji is non-analogous art. (*See* Resp. Br. PO 13-14). Shoji is within the same field of endeavor as the subject matter of claims 1 and 9. Even if we assume without deciding that the pertinent field of endeavor relates narrowly to SFC or high pressure chromatography, one of ordinary skill in the art would have looked to other forms of chromatography for guidance in addressing the problem of accurately maintaining pressure and flow rate.

29. The testimony by the Patent Owner’s declarant stating that “I would not have looked to a [gas chromatography] reference in attempting to

solve the problem addressed by the claimed invention or to cure the deficiencies of a primary reference including a pump" (Chordia Decl., para. 46) because Shoji's system uses a bomb rather than a pump as a pressure source (*id*, para. 43) is not persuasive. Shoji, like the claimed subject matter, addresses the problem of obtaining steady flow of fluid with high degrees of accuracy of pressure and flow using an imprecise pressure source.

ANALYSIS

Claim 1 recites a system including "a differential pressure transducer, where the back-pressure regulator, forward pressure regulator, and the differential pressure transducer control the pressure drop across the restrictor." Claim 9 includes a similar limitation. Neither the Requester nor the Examiner has proven that Azimov's system includes pressure regulators and a differential pressure transducer that control the pressure drop across the restrictor or orifice. (*See* FF 5 and 14-17). We do not sustain the rejection of independent claims 1 and 9 under § 102(b) as being anticipated by Azimov. For similar reasons, we do not sustain the rejection of dependent claims 2, 10 and 11 under § 102(b) as being anticipated by Azimov.

Neither the Examiner nor the Requester persuasively explains how the Admitted Prior Art as set forth on pages 73 through 75 of the Request might remedy failure of Azimov to teach a differential pressure transducer, "where the back-pressure regulator, forward pressure regulator, and the differential pressure transducer control the pressure drop across the" restrictor or orifice as recited in claim 1. (*See* App. Br. PO 27). We do not sustain the rejection of claims 1, 2, 9, 12 and 13 under §103(a) as being unpatentable over

Azimov and the Admitted Prior Art. Neither does the Examiner or the Requester explain how the teachings of Wang as applied to claim 3 or Müller-Kuhrt as applied to claims 5-8 might remedy this failure. (*See* FF 18 and 19; *see also* App. Br. PO 28 and 29). We do not sustain the rejection of claim 3 under § 103(a) as being unpatentable over Azimov and Wang; the rejection of claim 5 under § 103(a) as being unpatentable over Azimov and Müller-Kuhrt; or the rejection of claim 6-8 under § 103(a) as being unpatentable over Azimov, the Admitted Prior Art and Müller-Kuhrt.

In rejecting claims 5-8 under § 103(a) as being unpatentable over Gertenbach, Azimov and Müller-Kuhrt, the Examiner finds that Gertenbach fails to teach the use of a differential pressure regulator. (FF 20). Azimov fails to remedy this deficiency. (FF 14-17; *see also* App. Br. PO 29-30). Neither the Examiner nor the Requester cites Müller-Kuhrt for a teaching which might remedy this deficiency. (*See* FF 19). We do not sustain the rejection of claims 5-8 under § 103(a) as being unpatentable over Gertenbach, Azimov and Müller-Kuhrt.

NEW GROUND OF REJECTION OF CLAIMS 1, 2 AND 9-11 UNDER § 103(A) AS BEING UNPATENTABLE OVER AZIMOV AND SHOJI

Azimov's system includes each and every limitation of claim 1 and claim 9 except a differential pressure transducer, where the pressure regulators and the differential pressure transducer control the pressure drop across the restrictor or orifice. (FF 6-9 and 13-16). In particular, Azimov's system *10* satisfies the positive limitations of the preamble of claim 1 insofar as it is a system which includes a pump. (*See* FF 6 and 13). Shoji describes a system including a forward pressure regulator *2* and a back-pressure

regulator surrounding a flow restrictor in the form of a resistance tube *3*. Shoji's back-pressure regulator consists of a control valve *5* controlled by a differential pressure sensor and a control portion *9*. (*See* FF 22 and 23).

"[W]hen a patent claims a structure already known in the prior art that is altered by the mere substitution of one element for another known in the field, the combination must do more than yield a predictable result." *KSR Int'l Co. v. Teleflex, Inc.*, 550 U.S. 398, 416 (2007). It would have been obvious to substitute an electrically-controlled pressure regulator for the mechanical back-pressure regulator *44* described in Azimov. More specifically, it would have been obvious to substitute the combination of a differential pressure transducer, similar to the differential pressure transducer *4* described by Shoji, and a control valve used as a pressure regulator, similar to the control valve *5* described by Shoji, for the mechanical back-pressure regulator *44* of Azimov's system. (*See* Req. 83 ("One of ordinary skill in the art would have recognized that the exemplary system of forward pressure regulator/restrictor/differential pressure regulator of *Shoji* where a differential pressure sensor (4) and the control portion (9) control the pressure drop across the restrictor (3) has an immediate application to *Azimov*.")). The combination of the differential pressure transducer and the control valve used as a pressure regulator would have operated in the same manner as the pressure regulator *44* in Azimov's system. The teachings of Shoji would have provided one of ordinary skill guidance in implementing the substitution.

Once one of ordinary skill in the art made the proposed substitution, the combination of the differential pressure transducer and the control valve, together with the forward pressure regulator *24* described by Azimov, would

have controlled the pressure drop across the flow regulating device *38* so as to maintain constant pressure level upstream and downstream of the flow regulation device *38*. (*See* FF 3). The difference between the upstream and downstream pressures would have controlled the pressure drop across the flow regulating device *38*, thereby controlling the flow rate. (*Cf*. FF 4, 24 and 25 (describing the control of upstream and downstream pressure levels to control the pressure drop across the flow regulating device)).

Thus, one of ordinary skill in the art would have had reason to substitute the combination of the differential pressure transducer and the control valve in order to cooperate with the forward pressure regulator *24* to control the pressure drop across the flow regulating device *38*. This is true despite Azimov's teaching to use the flow switch *32*, itself a differential pressure transducer (*see* FF 14), merely to monitor and shut off the pressure drop (*see* FF 16). If one substituted the combination of the differential pressure transducer and the control valve as taught by Shoji for the back-pressure regulator *44* of Azimov, one would have to allow the combination of the differential pressure transducer and the control valve to actively adjust to pressure fluctuations in order to maintain the constant downstream pressure level necessary for a steady pressure drop and flow rate. Azimov's teachings concerning the flow switch *32* would not have deterred one of ordinary skill in the art making the proposed substitution from using the forward pressure regulator *24*, the differential pressure transducer and the control valve to control the pressure drop across the flow regulation device *38*.

The system described by Azimov includes both a forward pressure regulator *24* and a back-pressure regulator *44* to maintain a steady pressure

drop across a flow restrictor located between the flow regulators. (FF 3 and 4). Shoji teaches substituting a less expensive pressure gauge for a more expensive forward pressure regulator upstream of the flow restrictor in a system using a bomb or tank as a pressure source. (FF 27). The Examiner reasons, and the Patent Owner argues, that this teaching would have discouraged one of ordinary skill in the art from applying the teachings of Shoji to Azimov's system as proposed by the Requester without also removing the relatively expensive forward pressure regulator upstream of the flow restrictor. (*E.g.*, Resp. Br. PO 6-7 (citing RAN 29) and 12-13). This argument is not persuasive because a known arrangement of parts would not have been non-obvious merely because one of the parts was relatively expensive. *In re Farrenkopf*, 713 F.2d 714, 718 (Fed. Cir. 1983) ("That a given combination would not be made by businessmen for economic reasons does not mean that persons skilled in the art would not make the combination because of some technological incompatibility. Only the latter fact would be relevant."). (*See also* Reb. Br. Req'r 11-12; Record of Oral Hearing 26, ll. 12-17). Furthermore, the Examiner's reasoning fails to take into account the teachings of the art as a whole.

"[A] given course of action often has simultaneous advantages and disadvantages, and this does not necessarily obviate motivation to combine." *Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d 1157, 1165 (Fed. Cir. 2006). Azimov's system *10*, in which a "pump apparatus" drives the flow (FF 2), includes both a forward pressure regulator *24* and a back pressure regulator *44*. Azimov describes the system *10* as being designed to "provide a linear flow system of static parameters to accurately and continuously maintain a constant rate of flow of a fluid or a gas to a discharge point *despite*

significant fluctuations in supply line and discharge line pressures." (FF 1, quoting Azimov, col. 3, ll. 21-26 (italics added for emphasis)). On the other hand, Shoji teaches the use of a bomb or pressurized tank to drive flow through a gas chromatography system. (*See* FF 21 and 26). A bomb or pressure tank used as a pressure source will not cause flow oscillations similar to the fluctuations produced by a pump. (Chordia Decl., paras. 20 and 43). Despite Shoji's teaching that one might satisfactorily regulate flow driven by a bomb or pressure tank, it would have been obvious to one of ordinary skill in the art that both an upstream forward pressure regulator and a downstream back pressure regulator as taught by Azimov could have been used effectively to control the fluctuations produced when using a pump as a pressure source. Shoji's teaching to replace a relatively expensive forward pressure regulator with a pressure gauge when using a bomb as a pressure source would not have discouraged one of ordinary skill in the art from using such a forward pressure regulator when using a pump as a pressure source.

In addition, the Patent Owner argues that "Azimov teaches a static system, and as such, teaches away from the active controls of the ′609 patent claims." (App. Br. PO 25; *see also* Resp. Br. PO 14). Azimov teaches to "provide a linear flow system of *static parameters* to accurately and continuously maintain a constant rate of flow of a fluid or a gas to a discharge point despite significant fluctuations in supply line and discharge line pressures." (FF 1, quoting Azimov, col. 3, ll. 21-26 (italics added for emphasis)). Azimov also states that "it is evident that there is no need for a by-pass line to sample internal conditions and to regulate the system; a linear self-maintained system results." (FF 4, quoting Azimov, col. 3, ll. 56-59).

Although Azimov teaches a "self-maintained system" using "static parameters," it does not teach the use of static or inactive pressure regulators. At the very least, Azimov's pressure regulators would have to regulate transients, such as those occurring at system start-up or following significant fluctuations in supply line and discharge pressure. Furthermore, as the Requester points out at pages 18-19 of the Requester's Respondent Brief, the adjustability of the system implies that the pressure regulators actively maintain pressure and flow static parameters across the flow restrictor.

It would have been obvious from the combined teachings of Azimov and Shoji the use a forward pressure regulator, a back-pressure regulator and a differential pressure transducer to control the pressure drop across a restrictor. As discussed earlier, Azimov teaches the use of a forward pressure regulator *24* upstream of a restrictor or flow regulation device *38*; and a back-pressure regulator *44* downstream of the restrictor to control the pressure drop across the restrictor. Shoji teaches using the combination of a differential pressure transducer and a control valve to act as a back-pressure regulator. It would have been obvious from the combined teachings of Azimov and Shoji to substitute the combination of the differential pressure transducer and the control valve taught by Shoji for the back-pressure regulator described by Azimov so that the combination might act as a back-pressure regulator in Azimov's system. This substitution presupposes that the differential pressure transducer substituted with the control valve into Azimov's system acts to control the pressure drop across the restrictor or flow regulation device *38* rather than merely monitoring and shutting off the flow as does Azimov's flow switch *32*. If the differential pressure

transducer merely monitored the pressure and signaled the control valve to shut off the flow, the combination of the differential pressure transducer and the control valve would not have performed the same function as the back-pressure regulator described by Azimov and would not have been a suitable substitute.

Although Azimov teaches that there is no need for a by-pass line to sample internal conditions and to regulate the system, Azimov does not criticize or disparage the use of electrically-controlled pressure regulators. (FF 6). Consequently, Azimov would not have taught away from the substitution of an active electronic pressure regulator driven by a differential pressure transducer for a purely mechanical pressure regulator. For these reasons, we agree with the Requester that the subject matter of claim 1 would have been obvious from the combined teachings of Azimov and Shoji.

Claim 2 recites the "system of claim 1, wherein the restrictor is a precision orifice." Azimov describes the flow regulating device *38* as taking in the form of an orifice. (FF 3; *see also* Request, App'x CC-B at 8, citing Azimov, col. 4, ll. 41-45). Therefore, we agree with the Requester that the subject matter of claim 2 would have been obvious from the combined teachings of Azimov and Shoji.

As noted earlier, the preamble of independent claim 9 is not a limitation on the claim except for the limitation that the claimed system must be a "system for using a pump." Azimov teaches the use of a pump for driving a flow stream. (*See* FF 2). Azimov's system includes an orifice, that is, the flow regulation device *38*, located downstream from the pump; a first, forward pressure regulator *24* upstream of the restrictor or flow regulation

device *38*; and second, back-pressure regulator *44* downstream of the restrictor. (*See* FF 3). As noted earlier, it would have been obvious to merely substitute the combination of a differential pressure transducer and a control valve as taught by Shoji for the back-pressure regulator described by Azimov. Once the substitution was made, the first, forward pressure regulator *24*; the second regulator in the form of the control valve; and the differential pressure transducer would have controlled the pressure drop across the orifice, that is, the flow regulation device *38*. Therefore, we agree with the Requester that the subject matter of claim 9 would have been obvious from the combined teachings of Azimov and Shoji.

Claim 10 recites the "system of claim 9, wherein: the first pressure regulator is a forward pressure regulator." Claim 11 recites the "system of claim 9, wherein: the second pressure regulator is [a] back pressure regulator." The first pressure regulator in Azimov's system was the forward pressure regulator *24*. (*See* FF 3; *see also* Request 25-26). It would have been obvious to substitute the combination of the differential pressure regulator and the control valve as taught by Shoji for the second, back-pressure regulator *44* described by Azimov. Once the substitution was made, the control valve would have regulated the pressure upstream of the control valve to control the pressure drop across the flow regulation device *38*. In other words, the control valve would have been a second, back-pressure regulator. Therefore, we agree with the Requester that the subject matter of claims 10 and 11 would have been obvious from the combined teachings of Azimov and Shoji.

We decline to enter new grounds of rejection against claims 12 and 13. Claim 12 recites the "system of claim 1, wherein the flow stream

comprises CO_2." Claim 13 recites the "system of claim 9, wherein the flow stream comprises CO_2." The Requester does not explain how either Azimov or Shoji, or a combination of the two, teaches or suggests these limitations.

DECISION

We REVERSE the Examiner's rejections of claims 1-3 and 5-13.

Pursuant to our authority under 37 C.F.R. § 41.77(b), we enter a new ground of rejection against claims 1, 2 and 9-11 under § 103(a) as being unpatentable over Azimov and Shoji.

NEW GROUND OF REJECTION

37 C.F.R. § 41.77(b) states that "[a]ny decision which includes a new ground of rejection pursuant to this paragraph shall not be considered final for judicial review." Furthermore,

> When the Board makes a new ground of rejection, the owner, within one month from the date of the decision, must exercise one of the following two options with respect to the new ground of rejection to avoid termination of the appeal proceeding as to the rejected claim:
>
> (1) *Reopen prosecution*. The owner may file a response requesting reopening of prosecution before the examiner. Such a response must be either an amendment of the claims so rejected or new evidence relating to the claims so rejected, or both.
>
> (2) *Request rehearing*. The owner may request that the proceeding be reheard under § 41.79 by the Board upon the same record. The request for rehearing must address any new ground

> of rejection and state with particularity the points believed to have been misapprehended or overlooked in entering the new ground of rejection and also state all other grounds upon which rehearing is sought.

Requests for extensions of time in this *inter partes* reexamination proceeding are governed by 37 C.F.R. § 1.956 (2011). *See* 37 C.F.R. § 41.79 (2011).

<u>REVERSED; 37 C.F.R. § 41.77(b)</u>

peb

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US006648609B2

(12) United States Patent

Berger et al.

(10) Patent No.: US 6,648,609 B2

(45) Date of Patent: Nov. 18, 2003

(54) **PUMP AS A PRESSURE SOURCE FOR SUPERCRITICAL FLUID CHROMATOGRAPHY INVOLVING PRESSURE REGULATORS AND A PRECISION ORIFICE**

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(73) Assignee: **Berger Instruments, Inc.**, Newark, DE (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(22) Filed: **Apr. 5, 2002**

(65) **Prior Publication Data**

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(51) **Int. Cl.**[7] **F04B 49/08**

(52) **U.S. Cl.** **417/297**; 417/292; 417/248; 137/613; 137/614.2; 137/512; 251/118; 210/198.2; 73/23.42; 73/61.56

(58) **Field of Search** 417/292, 297, 417/248; 137/613, 614.2, 512; 251/118; 210/198.2; 73/23.41, 23.42, 61.55, 61.56

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,042,326 A * 8/1977 Kallos 436/126
4,095,472 A * 6/1978 Mowery, Jr. 73/61.56
4,690,689 A * 9/1987 Malcosky et al. 48/174
4,990,076 A * 2/1991 Lynch et al. 422/112
5,094,741 A * 3/1992 Frank et al. 210/198.2
5,133,859 A 7/1992 Frank et al.
5,151,250 A * 9/1992 Conrad 422/2
5,240,603 A 8/1993 Frank et al.
5,378,229 A * 1/1995 Layer et al. 604/31
5,431,545 A * 7/1995 Knight et al. 417/248
5,797,719 A 8/1998 James et al.
5,888,050 A 3/1999 Fitzgerald et al.
6,309,541 B1 * 10/2001 Maiefski et al. 210/198.2
6,413,428 B1 * 7/2002 Berger et al. 210/634
6,503,396 B2 * 1/2003 Kim et al. 210/634

* cited by examiner

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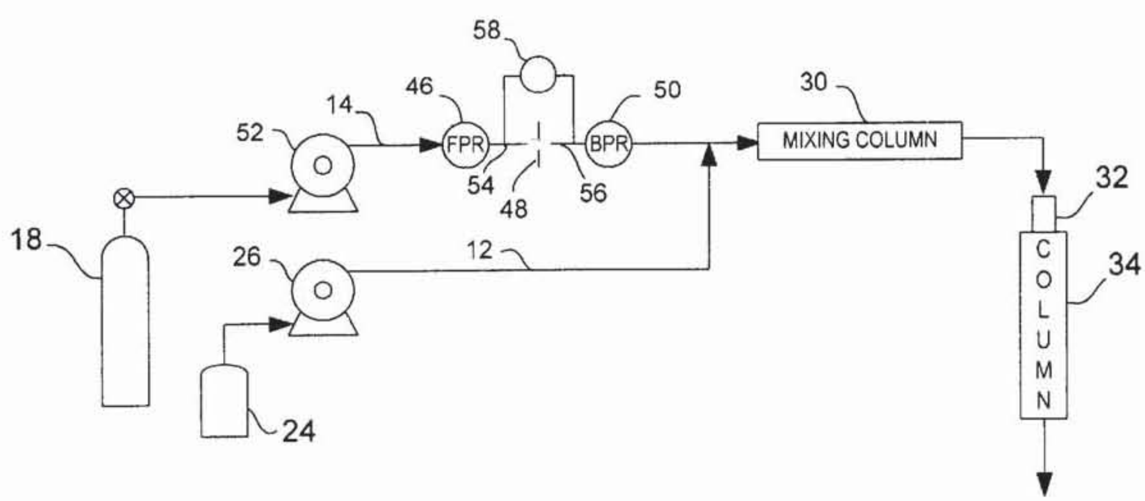
(57) **ABSTRACT**

The invention is a device and method in a high-pressure chromatography system, such as a supercritical fluid chromatography (SFC) system, that uses a pump as a pressure source for precision pumping of a compressible fluid. The preferred exemplary embodiment comprises a pressure regulation assembly installed downstream from a compressible fluid pump but prior to combining the compressible flow with a relatively incompressible modifier flow stream. The present invention allows the replacement of an high-grade SFC pump in the compressible fluid flow stream with an inexpensive and imprecise pump. The imprecise pump becomes capable of moving the compressible fluid flow stream in a precise flow rate and pattern. The assembly dampens the damaging effects of an imprecise pump, such as large pressure oscillations caused by flow ripples and noisy pressure signals that do not meet precise SFC pumping requirements.

11 Claims, 6 Drawing Sheets



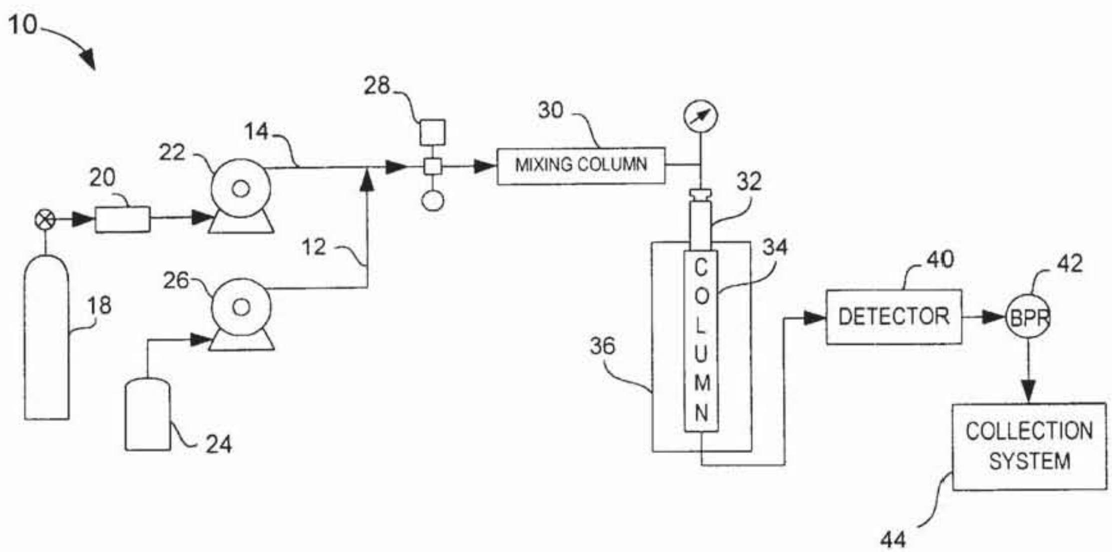


FIGURE 1
PRIOR ART

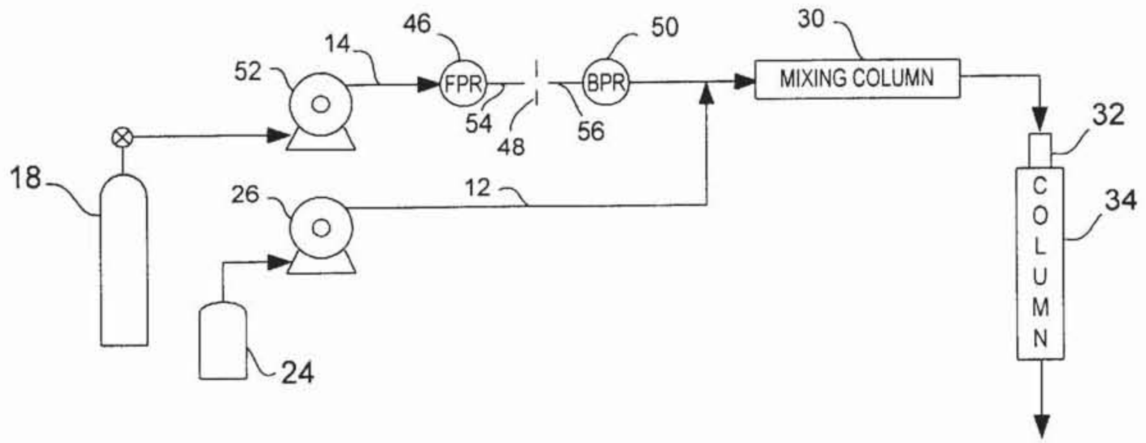

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FIGURE 2

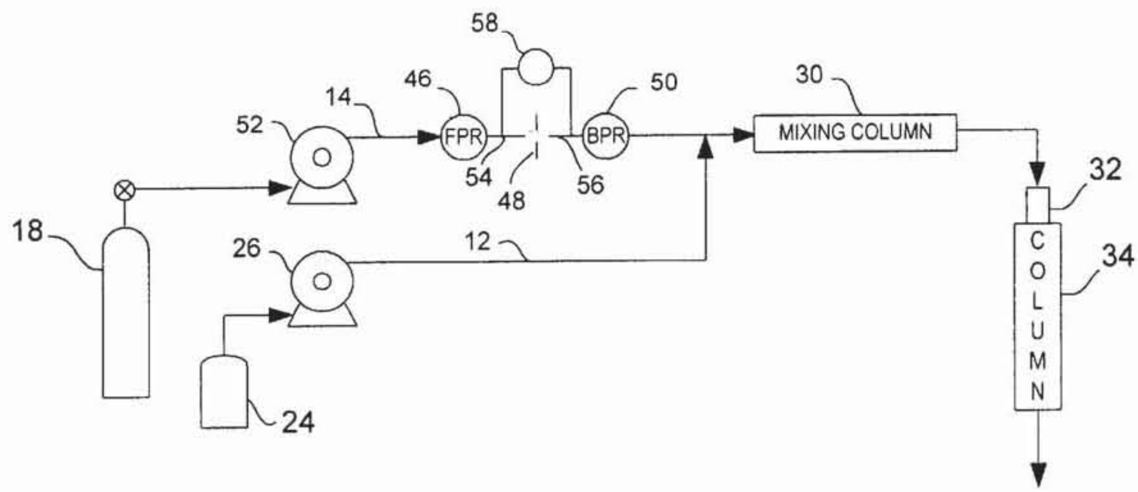
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FIGURE 3

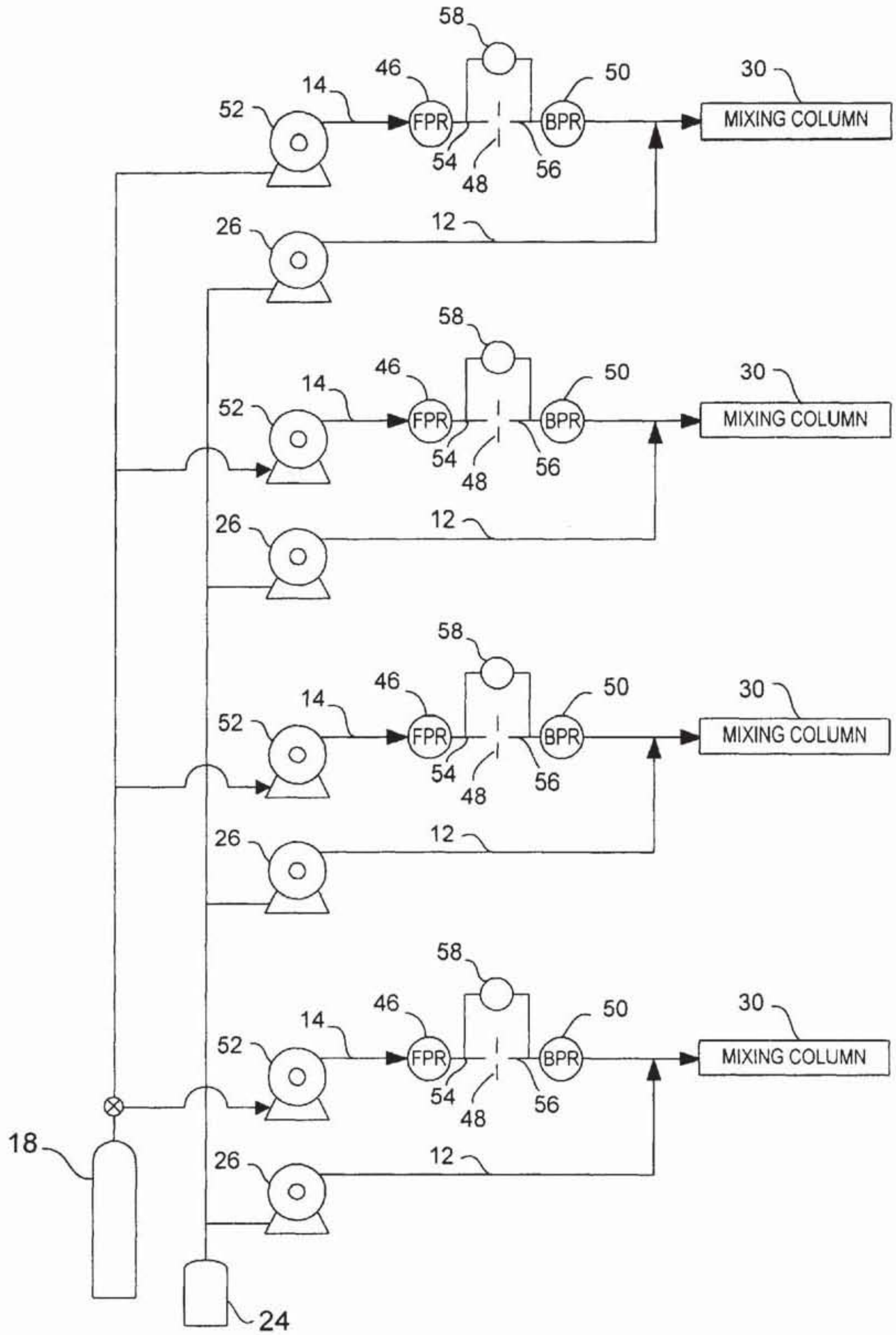
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FIGURE 4

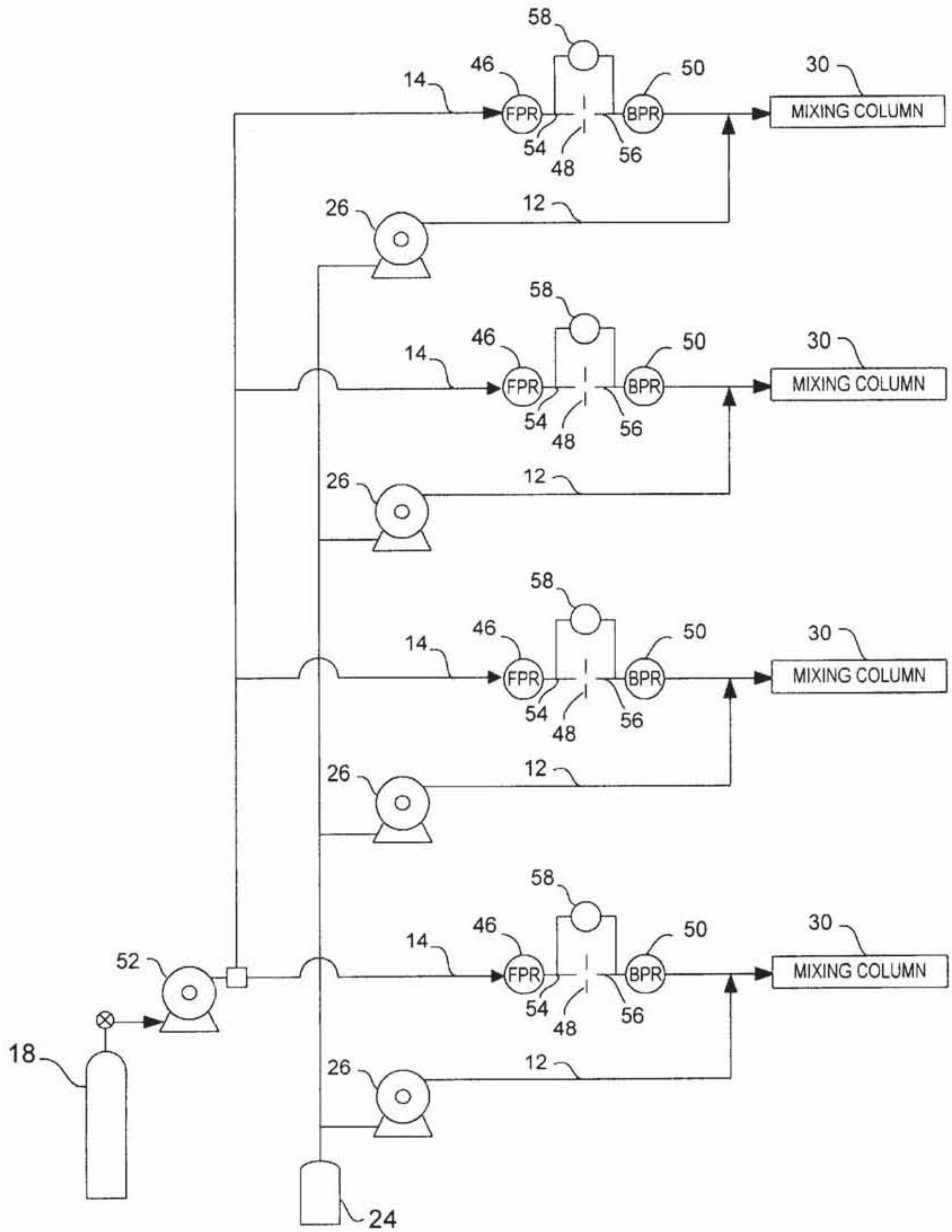

FIGURE 5

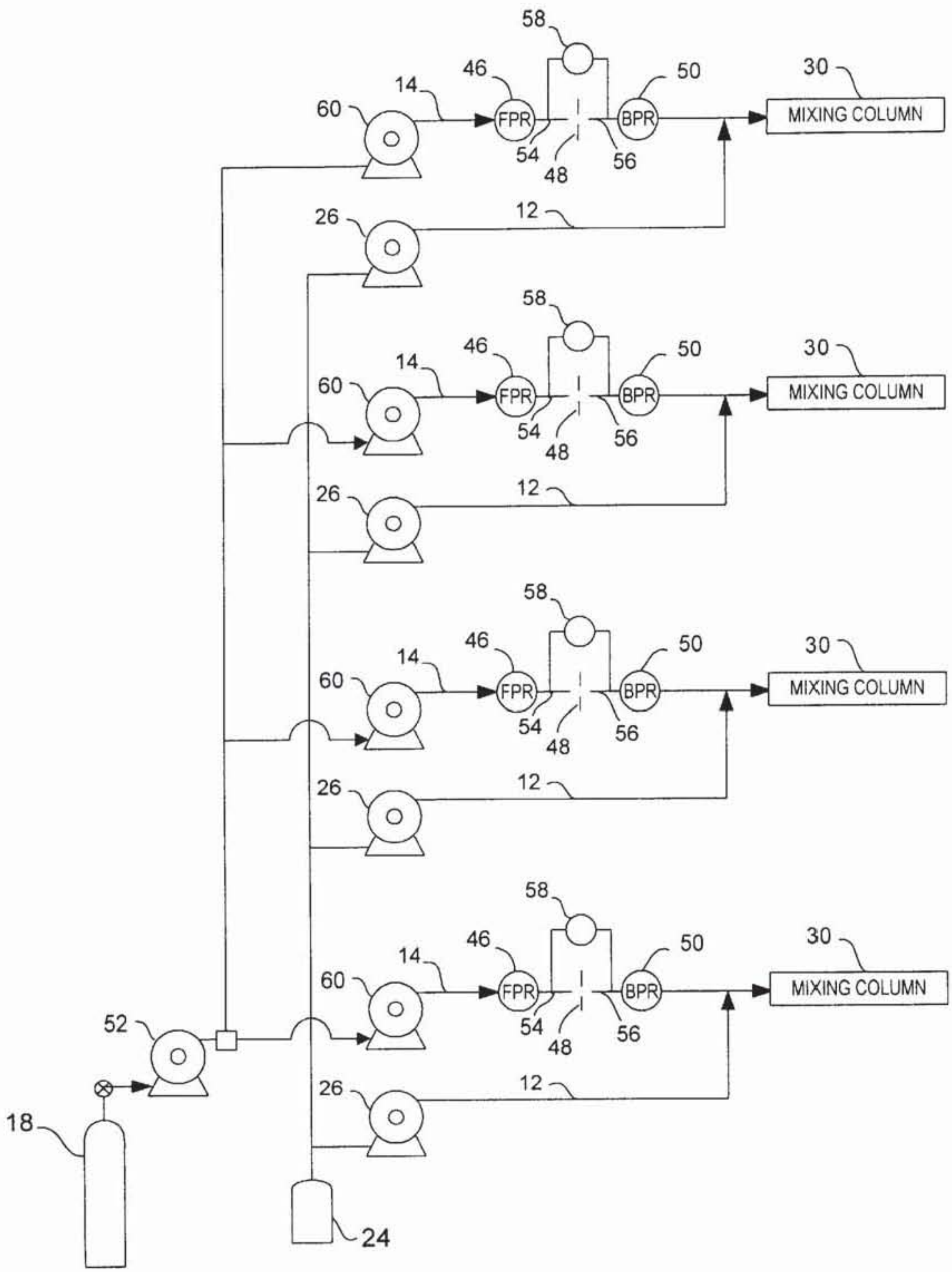
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FIGURE 6

PUMP AS A PRESSURE SOURCE FOR SUPERCRITICAL FLUID CHROMATOGRAPHY INVOLVING PRESSURE REGULATORS AND A PRECISION ORIFICE

FIELD OF THE INVENTION

The invention relates to a device and method for using a pump as a pressure source, instead of a flow source, in a high-pressure chromatography system, such as supercritical fluid chromatography.

BACKGROUND OF THE INVENTION

An alternative separation technology called supercritical fluid chromatography (SFC) has advanced over the past decade. SFC uses highly compressible mobile phases, which typically employ carbon dioxide (CO2) as a principle component. In addition to CO2, the mobile phase frequently contains an organic solvent modifier, which adjusts the polarity of the mobile phase for optimum chromatographic performance. Since different components of a sample may require different levels of organic modifier to elute rapidly, a common technique is to continuously vary the mobile phase composition by linearly increasing the organic modifier content. This technique is called gradient elution.

SFC has been proven to have superior speed and resolving power compared to traditional HPLC for analytical applications. This results from the dramatically improved diffusion rates of solutes in SFCmobile phases compared to HPLC mobile phases. Separations have been accomplished as much as an order of magnitude faster using SFC instruments compared to HPLC instruments using the same chromatographic column. A key factor to optimizing SFC separations is the ability to independently control flow, density and composition of the mobile phase over the course of the separation. SFC instruments used with gradient elution also reequillibrate much more rapidly than corresponding HPLC systems. As a result, they are ready for processing the next sample after a shorter period of time. A common gradient range for gradient SFC methods might occur in the range of 2% to 60% composition of the organic modifier.

It is worth noting that SFC instruments, while designed to operate in regions of temperature and pressure above the critical point of CO2, are typically not restricted from operation well below the critical point. In this lower region, especially when organic modifiers are used, chromatographic behavior remains superior to traditional HPLC and often cannot be distinguished from true supercritical operation.

A second analytical purification technique similar to SFC is supercritical fluid extraction (SFE). Generally, in this technique, the goal is to separate one or more components of interest from a solid matrix. SFE is a bulk separation technique, which does not necessarily attempt to separate individually the components, extracted from the solid matrix. Typically, a secondary chromatographic step is required to determine individual components. Nevertheless, SFE shares the common goal with prep SFC of collecting and recovering dissolved components of interest from supercritical flow stream. As a result, a collection device suitable for preparative SFC should also be suitable for SFE techniques.

Packed column SFC uses multiple, high pressure, reciprocating pumps, operated as flow sources, and independent control of system pressure through the use of electronic back

pressure regulators. Such a configuration allows accurate reproducible composition programming, while retaining flow, pressure, and temperature control. Reciprocating pumps are generally used in supercritical fluid chromatography systems that use a packed chromatography column for elution of sample solute. Reciprocating pumps can deliver an unlimited volume of mobile phase with continuous flow, typically pumping two separate flow streams of a compressible supercritical fluid and incompressible modifier fluid that are combined downstream of the pumping stages to form the mobile phase. Reciprocating pumps for SFC can be modified to have gradient elution operational capabilities.

A great deal of subtlety is required to pump fluids in SFC. Not any reciprocating pump can be used with a pump head chiller to make an SFC pump. While most HPLC pumps can be set to compensate for the compressibility, compensation is too small to deal with the fluids most often used in SFC. To attempt to minimize the compressibility range required, the pump is usually chilled to insure the fluid is a liquid, far from its critical temperature. Chilled fluids are dense but are still much more compressible than the normal liquids used in HPLC. To control flow accurately, the pump must have a larger than expected compressibility compensation range. Further, since the compressibility changes with pressure and temperature, the pump must be capable of dynamically changing compressibility compensation. Inadequate compensation results in errors in both the flow rate and the composition of modified fluids.

Without correct compressibility compensation, the pump either under- or over-compresses the fluid causing characteristic ripples in flow and pressure. Either under- or over-compression results in periodic variation in both pressure and flow with the characteristic frequency of the pump (ml/min divided by pump stroke volume in ml). The result is noisy baselines and irreproducibility. To compensate for this, the more expensive and better liquid chromatography pumps have compressibility adjustments to account for differences in fluid characteristics.

SFC systems in the prior art have used modified HPLC high-pressure pumps operated as a flow source. One pump delivered compressible fluids, while the other was usually used to pump modifiers. A mechanical back pressure regulator controlled downstream pressure. The pumps used a single compressibility compensation, regardless of the fluids used. The compressible fluid and the pump head were cooled near freezing. The delivery of carbon dioxide varied with pressure and flow rate. The second pump delivered accurate flows of modifier regardless of pressure and flow. At different pressures and flows, the combined pumps delivered different compositions although the instrument setpoints remained constant. Pumping compressible fluids, such as CO2, at high pressures in SFC systems while accurately controlling the flow, is much more difficult than that for a liquid chromatography system. SFC systems use two pumps to deliver fluids to the mobile phase flow stream, and each pump usually adds pressure and flow ripples and variances that cause baseline noise. The two pumps also operate at different frequencies, different flow rates, and require separate compressibility compensations, further adding to the complexity of flow operations.

Methods in the prior art calculate ideal compressibility based on measured temperature and pressure using a sophisticated equation of state. The method then uses dithering around the setpoint to see if a superior empirical value can be found. This approach is described in U.S. Pat. No. 5,108,264, Method and Apparatus for Real Time Compensation of Fluid Compressibility in High Pressure Recipro-

cating Pumps, and U.S. Pat. No. 4,883,409, Pumping Apparatus for Delivering Liquid at High Pressure. Other prior art methods move the pump head until the pressure in the refilling cylinder is nearly the same as the pressure in the delivering pump head. One method in U.S. Pat. No. 5,108,264 Method and Apparatus for Real Time Compensation of Fluid Compressibility in High Pressure Reciprocating Pumps, adjusts the pumping speed of a reciprocating pump by delivering the pumping fluid at high pressure and desired flow rate to overcome flow fluctuations. These are completely empirical forms of compressibility compensation. The prior art methods require control of the fluid temperature and are somewhat limited since they does not completely compensate for the compressibility. The compensation stops several hundred psi from the column inlet pressure.

In SFC, it is common to use very long columns with large pressure drops to generate very high efficiency compared to HPLC. The use of long columns resulted from a change in control philosophy. Earlier in SFC technology, the pump was used as the pressure controller. the column outlet pressure was not controlled. Long columns produced large pressure drops, and at modest inlet pressures, the outlet pressure could drop to the point where several sub-critical phases could exist. The co-existence of several phases destroys chromatographic separations and efficiency. Controlling the column outlet pressure, the pump becomes a flow source, not a pressure source. Consequently, the point in the system with the worst solvent strength becomes the control point. All other positions in the system have greater solvent strength. By controlling this point, problems associated with phase separations or solubility problems at uncontrolled outlet pressures are eliminated.

The compressibility of the pumping fluid directly effects volumetric flow rate and mass flow rate. These effects are much more noticeable when using compressible fluids such as carbon dioxide in SFC rather than fluids in liquid chromatography. The assumption of a constant compressibility leads to optimal minimization of fluid fluctuation at only one point of the pressure/temperature characteristic, but at other pressures and temperatures, flow fluctuations occur in the system.

The flow rate should be kept as constant as possible through the separation column. If the flow rate fluctuates, variations in the retention time of the injected sample would occur such that the areas of the chromatographic peaks produced by a detector connected to the outlet of the column would vary. Since the peak areas are representative for the concentration of the chromatographically separated sample substance, fluctuations in the flow rate would impair the accuracy and the reproducibility of quantitative measurements. At high pressures, compressibility of solvents is very noticeable and failure to account for compressibility causes technical errors in analyses and separation in SFC.

The type of pump control philosophy in an SFC system affects resolution in pressure programming. A pressure control pump with a fixed restrictor results in broadened peaks and higher background noise through a packed column. Efficiency degrades as pressure increases. A flow control pump with a back-pressure regulator has better resolution results through a packed column and steady background. Efficiency remains constant with increasing pressure. With independent flow control, the chromatographic linear velocity is dictated by the pump, and remains near optimum, throughout a run. The elution strength is controlled separately, using a back-pressure regulator. With pressure controlled pumps, a fixed restrictor passively limits flow. The linear velocity increases excessively during a run, thereby degrading the chromatography.

Therefore, a need exists for a system that uses a pump as a pressure source in SFC without degrading the chromatography results.

SUMMARY

The exemplary embodiment is useful in a high-pressure chromatography system, such as a supercritical fluid chromatography (SFC) system, for using a pump as a pressure source for precision pumping of a compressible fluid. The preferred exemplary embodiment comprises a pressure regulation assembly installed downstream from a compressible fluid pump but prior to combining the compressible flow with a relatively incompressible modifier flow stream that allows the replacement of an high-grade SFC punp in the compressible fluid flow stream with an inexpensive and imprecise pump. The imprecise pump becomes capable of moving the compressible fluid flow stream in a precise flow rate and pattern. The assembly dampens the damaging effects of an imprecise pump, such as large pressure oscillations caused by flow ripples and noisy pressure signals that do not meet precise SFC pumping requirements.

The invention regulates the outlet pressure from a pump using a system of pressure regulators and a restriction in the flow stream. To regulate outlet pressure directly downstream of a pump, a forward-pressure regulator (FPR) is installed in the flow line. Downstream of the forward-pressure regulator the flow is restricted with a precision orifice. The orifice can be any precision orifice, such as a jewel having a laser-drilled hole or precision tubing. Downstream of the orifice is a back-pressure regulator (BPR). The series of an FPR-orifice-BPR is designed to control the pressure drop across the orifice, which dampens out oscillation from noisy pressure signals caused by large ripples in the flow leaving the pump. An additional embodiment uses a differential pressure transducer around the orifice with a servo control system to further regulate the change in pressure across the orifice. The combination allows the replacement of an expensive, SFC-grade pump having compressibility compensation with an inexpensive, imprecise pump such as an air-driven pump.

The system can be multiplexed in parallel flow streams, thereby creating significantly greater volumetric capacity in SFC and a greater number of inexpensive compressible fluid flow channels. The parallel streams can all draw from a single source of compressible fluid, thereby reducing the costs of additional pumps. Some alternatives to the multiplexed system uses the single compressible fluid pump to raise pressure in the flow line from the compressible fluid source combined with additional second stage booster pumps in each individual SFC flow stream. Another system replaces multiple modifier solvent pumps for each channel with a single, multi-piston pump having outlets for each individual channel.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the nature of the present invention, reference is had to the following figures and detailed description, wherein like elements are accorded like reference numerals, and wherein:

FIG. 1 is a flow diagram of an supercritical fluid chromatography system.

FIG. 2 is a schematic of a compressible fluid flow stream with the preferred embodiment.

FIG. 3 is a schematic of a compressible fluid flow stream with an alternative embodiment.

FIG. **4** is a schematic of a multiplexed compressible fluid flow stream using the invention in parallel with multiple pumps.

FIG. **5** is a schematic of a multiplexed compressible fluid flow stream using the invention in parallel with a single pump.

FIG. **6** is a schematic of a multiplexed compressible fluid flow stream using the invention in parallel with two pumps.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

There is described herein a preferred embodiment of the present invention for a device and method in a high-pressure chromatography system, such as supercritical fluid chromatography (SFC), that uses a pump as a pressure source for precision pumping of a compressible fluid. As further described herein, the preferred exemplary embodiment comprises a pressure regulation assembly installed downstream from a compressible fluid pump but prior to combining the compressible flow with a relatively incompressible flow stream. The present invention provides for the replacement of an expensive SFC-grade pump for compressible fluids having dynamic compressibility compensation, with a less-expensive and imprecise pump to move a compressible fluid flow stream in a precise flow rate and pressure signal. The assembly dampens the damaging effects of a low-grade pump, such as large pressure and flow oscillations caused by flow ripples and noisy pressure signals that do not meet precise SFC pumping requirements.

Components of an SFC system **10** are illustrated in the schematic of FIG. **1**. The system **10** comprises two independent flow streams **12**, **14** combining to form the mobile phase flow stream. In a typical SFC pumping assembly, a compressible fluid, such as carbon dioxide (CO2), is pumped under pressure to use as a supercritical solvating component of a mobile phase flow stream. Tank **18** supplies CO2 under pressure that is cooled by chiller **20**. Due to precise pumping requirements, SFC systems commonly use an SFC-grade reciprocating piston pump having dynamic compressibility compensation.

A second independent flow stream in the SFC system provides modifier solvent, which is typically methanol but can be a number of equivalent solvents suitable for use in SFC. Modifier is supplied from a supply tank **24** feeding a second high-grade pump for relatively incompressible fluids **26**. Flow is combined into one mobile phase flow stream prior to entering mixing column **30**. The combined mobile phase is pumped at a controlled mass-flow rate from the mixing column **30** through transfer tubing to a fixed-loop injector **32** where a sample is injected into the flow stream.

The flow stream, containing sample solutes, then enters a chromatography column **34**. Column **34** contains stationary phase that elutes a sample into its individual constituents for identification and analysis. Temperature of the column **34** is controlled by an oven **36**. The elution mixture leaving column **34** passes from the column outlet into detector **40**. Detector **40** can vary depending upon the application, but common detectors are ultraviolet, flame ionization (with an injector- or post-column split), or GC/MS. After analysis through the detector **40**, the mobile phase flow stream passes through a back-pressure regulator (BPR) **42**, which leads to a downstream sample fraction collection system **44**.

For precision SFC pumping, pump **22** must have some type of compressibility compensation, otherwise pressure ripples and flow fluctuations will result in noisy baselines and irreproducibility of flow rates and pressures. Compressibility compensation accounts for under or over-compensation in the piston and differences in fluid compressibilities. High-pressure SFC pumps used as flow sources have an extended compressibility range and the ability to dynamically change the compression compensation. The compressibility of the pumping fluid directly effects volumetric flow rate and mass flow rate. These effects are much more noticeable when using compressible fluids, such as CO2, in SFC systems than fluids in liquid chromatography. The assumption of a constant compressibility leads to optimal minimization of fluid fluctuation at only one point the pressure/temperature characteristic, but at other pressures and temperatures, flow fluctuations occur in the system. If the mobile phase flow rate is not kept as constant as possible through the column, variation in the retention time of the injected sample to the outlet of the columns would vary. Since the peak areas are representative of the concentration of the separated sample solutes, fluctuations in the flow rate would impair the accuracy and the reproducibility of quantitative measurements. At high pressures, compressibility of solvents is very noticeable and failure to account for compressibility causes technical errors in analyses and separation in SFC.

FIG. **2** is a schematic of an SFC system with the device of the preferred exemplary embodiment installed on flow line **14**, containing compressible supercritical fluid. After pump source **52**, a forward pressure regulator (FPR) **46** is installed on flow line **14**. After the FPR **46**, a type of fixed restrictor **48** is followed by a back-pressure regulator (BPR) **50**. The FPR **46** installed directly downstream of pump source **52** dampens out oscillation from noisy pressure signals caused by large ripples in the flow leaving pump source **52**. This effect provides near-constant outlet pressure from pump source **52**. Downstream of the FPR is tubing **54** connected on opposite sides of a fixed restrictor **48**. In the preferred embodiment, the fixed restrictor **48** is a precision orifice. The orifice can be any precision orifice, such as a jewel having a laser-drilled hole or precision tubing.

Any types of FPRs and BPRs capable of use in SFC systems may be implemented for the present invention. Pressure regulators **46**, **50** may be mechanically, electro-mechanically, or thermally controlled. Pressure regulators **46**, **50** should have low dead volumes if peak collection is an important result. Some older generation pressure regulators **46**, **50** have dead volumes as high as 5 ml and therefore should be avoided. Pressure regulators may also be heated to prevent the formation of solid particles of the mobile phase from forming.

The configuration of a precision orifice **48** between an FPR **46** and BPR **50** is designed to control the pressure drop ΔP across the orifice **48**. Controlling ΔP will control the flow of compressible fluid in the system. The flow past the orifice **48** should remain as close to constant temperature as possible. Changing the size of the orifice **48** changes the flowrate range. The invention can operate with some drop in pressure if there is little temperature change. If there is a drop in ΔP in addition to cooling across orifice **48**, the positive effects of flow control begin to degrade. The orifice is set to create a restriction which limits the mass flow rate. With fixed restrictors, SFC must achieve operating pressures by varying the flow rates. The size of the static orifice can be changed to create discrete pressure levels at flow rate that provide the same integrated mass of expanded mobile phase at each pressure setting.

The preferred embodiment operates most efficiently for small ΔP across the single orifice **48**, sending flow from repeated injections of similar samples through a single

column **34** while knowing the gradient of flow. To assist in maintaining the constant flow stream, the pressure source **52** pumps flow at a pressure higher than any pressure required throughout the system. For example, CO2 flow rates may range from 37.5 ml/minute to 25 ml/minute at pressures up to 400 bar. As one skilled in the art will understand, alternative embodiments of the invention can operate under conditions that can vary significantly from exemplary embodiments. For example, a variable orifice can change ΔP and the flow rate according to adjustments made by a control system.

According to the present invention, an SFC pump is converted from a flow source into using the pump as a pressure source while continuing to control the flow rate. The preferred embodiment allows for constant mass flow of compressible fluids and even provides for constant mass flow in the presence of rising outlet pressure. As the pump **52** sends mobile phase through the column and more fluid from both flow streams are pumped together, and pressure rises in the flow stream independent of the fact that less percentage of CO2 is being pumped. After the CO2 leaves the BPR **50**, the pressure drops to an undefined value, which is in the column inlet pressure. The column inlet pressure has no effect on flow control of the present invention unless the column pressure becomes too high through a system malfunction or inadvertent operator mistake. Pump **52** is also operated at a pressure higher than any downstream pressure requirements. With these operating conditions, the described system is useful in a system built for analytical or semi-preparatory to preparatory supercritical fluid chromatography but may also be used in HPLC or supercritical fluid extraction systems.

By utilizing the series of pressure regulators **46**, **50** with a precision orifice **48** placed after a pressure source **52** in the compressible fluid flow stream **14**, a high cost SFC-grade pump can be replaced with an inexpensive, lower-grade pump. An example of a replacement for pump **22** is a piston-drive pneumatic pump **52**. An air driven pump can be modified for use in an SFC system to deliver compressible fluids at extremely high pressures, such as 10,000 psi. A pneumatic pump is not typically used in SFC systems because of significant problems with imprecise flow and pressure parameters, such as pressure ripples producing noisy pressure signals. The present invention provides precise flow by dampening out a noisy pressure signal and uneven flow so that a pneumatic pump functions as well as an SFC-grade reciprocating pump.

An alternative embodiment to the present invention is illustrated in FIG. **3**. The schematic of an SFC system shows a source of compressible fluid **18** feeding compressible fluid pump **52**. Flow line **14** feeds an FPR **46**, a fixed restrictor **48**, following by a BPR **50**. FPR **46** is installed directly downstream of pressure source **52** and dampens out oscillation from noisy pressure signals caused by large ripples in the flow leaving pump **52**, thereby providing nearly constant outlet pressure. In the alternative embodiment, the fixed restrictor **48** is a precision orifice. The orifice can be any precision orifice, such as a jewel having a laser-drilled hole or precision tubing. A differential pressure transducer **58** can be installed on flow lines **54** and **56** around restrictive orifice **48** to control ΔP across the orifice **48**. The differential transducer **58** is being used as a mass flow transducer and employs a servo control system for performing a servo algorithm to control the transducer **58** in accordance with the requirements of the present invention.

In an additional alternative embodiment, illustrated in FIG. **4**, flow channels of compressible fluid flow streams are multiplexed in parallel, thereby creating significantly greater volumetric capacity in SFC systems. Pumps **52** may draw from a single source of compressible source fluid **18**, such as CO2. Flow control is gained from pressure flow out of pumps **52** operating with duplicated series of a restrictive orifice **48** between FPR **46** and BPR **50**, according to the present invention. The multiplexed system is illustrated having a differential transducer **58** installed around restrictive orifice **48**, however as described in the preferred embodiment, flow control of a pressure source may be practiced without transducer **58**. Higher cost SFC-grade pumps are replaced with low-grade, imprecise compressible fluid pumps **52**, thereby providing a cost-effective plurality of channels of compressible flow streams.

FIG. **4** illustrates an individual modifier pump **26** fed by a common supply tank **24** for each modifier flow stream **12** that feeds into the compressible fluid flow stream prior to entering the mixing column **30** in each of the multiplexed pumping systems. An alternative embodiment to this design is to use a single modifier pump **26**, such as a multi-piston pump, that has multiple flow outlets that can feed multiple channels. A multi-piston pump draws modifier from tank **24** and distributes flow to each modifier flow stream **12** from the single pump. In the exemplary embodiment in FIG. **4**, a single four port multi-piston pump could substitute for the four modifier pumps **26** for the multiplexed system.

In an additional exemplary embodiment, illustrated in FIG. **5**, the compressible fluid flow stream of an SFC system is multiplexed in parallel from single pump **52**. For this application, outlet pressure of pump **52** is kept much higher than pressure used in a single flow channel. Flow is distributed to each parallel channel through any pressure distribution control device compatible with the compressible source fluid and the high-pressures necessary for SFC systems. Flow control is gained from pressure flow operating with duplicated series of a restrictive orifice **48** between FPR **46** and BPR **50** for each parallel channel. The multiplexed system is illustrated having a differential transducer **58** installed around restrictive orifice **48**, however as described in the preferred embodiment, flow control of a pressure source may be practiced without transducer **58**. A higher cost SFC-grade pump is replaced with low-grade, imprecise compressible fluid pump **52**, thereby providing a cost-effective plurality of channels of compressible flow streams.

Reference is made to FIG. **6**, illustrating another embodiment of the present invention. In this embodiment, compressible fluid flows to the restrictive orifice **48** from two pumps. The first is a compressible fluid pump **52** that is fed directly from the compressible fluid supply tank **18**. This pump **52** raises flow pressure to a consistent level very near the critical point. For example, pressure is raised by pump **52** between 200 and 1200 psi in the first stage. Pump **52** is then followed by a second stage booster pump **60** for each channel on the compressible fluid flow stream. The booster pump **60** raises pressure in the individual flow lines leading to orifice **48**. In an example, pressure in line **14** from pump **60** ranges from 1200 to 6000 psi.

The present invention is well suited for use in chromatography systems operating in the supercritical, or near supercritical, ranges of flow stream components. However, as one skilled in the art will recognize, the invention may be used in any system where it is necessary to obtain steady flow of liquid at high pressures with high degrees of accuracy of pressure and flow using an imprecise pressure source. Other applications may include supercritical fluid extraction systems or HPLC where separation and/or collection of sample contents into a high-pressure flow stream occurs.

Because many varying and different embodiments may be made within the scope of the inventive concept herein taught, and because many modifications may be made in the embodiments herein detailed in accordance with the descriptive requirements of the law, it is to be understood that the details herein are to be interpreted as illustrative and not in a limiting sense.

What is claimed:

1. A system for using a pump as pressure source in a flow stream containing a highly compressed gas, compressible liquid, or supercritical fluid, comprising:

a restrictor for restricting flow downstream of the pump;

a forward pressure regulator located upstream of the restrictor for controlling the outlet pressure from the pump; and

a back-pressure regulator located downstream of the restrictor, where the back-pressure and forward-pressure regulators control the pressure drop across the restrictor.

2. The system of claim **1**, wherein

the restrictor is a precision orifice.

3. The system of claim **1**, further comprising:

a temperature controller to control temperature across the restrictor such that the temperature remains as constant as practicable.

4. The system of claim **1**, further comprising:

a differential pressure transducer to control pressure drops across the restrictor.

5. The system of claim **1**, further comprising:

a plurality of channels of the flow streams in parallel where pressure is controlled in each channel with separate groups of the forward-pressure regulator, the restrictor, and the back-pressure regulator in each of the channels.

6. The system of claim **1**, further comprising:

a plurality of channels of the flow streams in parallel where pressure is controlled in each channel with separate groups of the pump, the forward-pressure regulator, the restrictor, and the back-pressure regulator for each of the channels.

7. The system of claim **6**, further comprising:

feeding each separate pump in each of the channels from a single source pump.

8. The system of claim **5**, further comprising:

a single multi-piston pump for combining second flow streams of a relatively incompressible fluid into each of the channels.

9. An system for using a pump as pressure source in a flow stream containing a highly compressed gas, compressible liquid, or supercritical fluid, comprising:

an orifice in the flow stream located downstream from the pump;

a first pressure regulators located upstream of the orifice; and

a second pressure regulator located downstream of the orifice, where the pressure regulators control the pressure drop across the orifice.

10. The system of claim **9**, wherein:

the first pressure regulator is a forward pressure regulator.

11. The system of claim **9**, wherein:

the second pressure regulator is back-pressure regulator.

* * * * *

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I hereby certify that on this 5th day of June, 2015, I caused this Corrected Brief of Appellant to be filed electronically with the Clerk of the Court using the CM/ECF System, which will send notice of such filing to the following registered CM/ECF users:

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Upon acceptance by the Clerk of the Court of the electronically filed document, the required number of copies of the Corrected Brief of Appellant will be hand filed at the Office of the Clerk, United States Court of Appeals for the Federal Circuit in accordance with the Federal Circuit Rules.

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